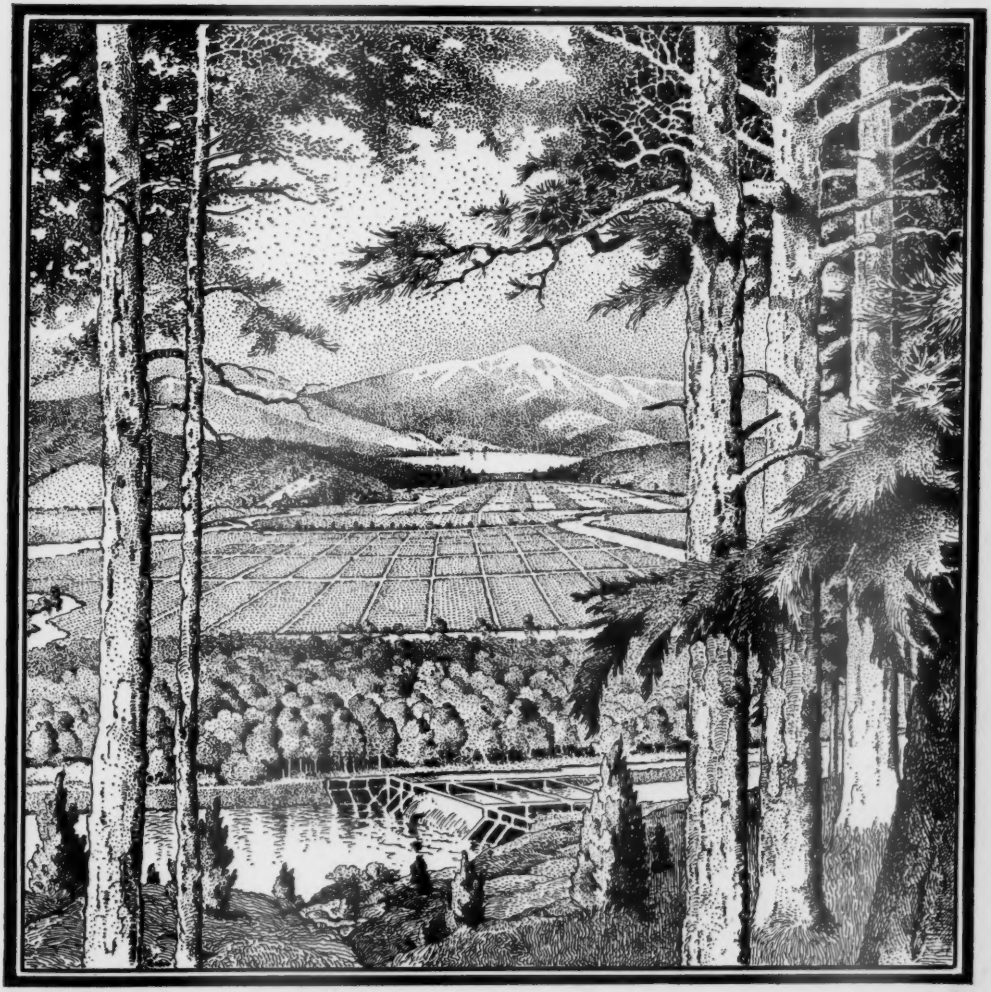
Irrigation Possibilities of the Lower Colorado River, by J. B. Lippincott

Vol. VIII—No. 4 APRIL, 1902 $2.00 A Year

FORESTRY & IRRIGATION



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H. HOBART NICHOLS 1902.

TEACHING FORESTRY AT BEREA COLLEGE, by Professor S. C. Mason

THE

National Irrigation Association

NATIONAL HEADQUARTERS, 1707 Fisher Building, CHICAGO, ILL.

Room 6, GLOVER BUILDING, WASHINGTON, D. C.

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The objects of the Association, as set forth in its Constitution, are as follows:

1. The adoption by the Federal Government of a permanent policy for the reclamation and settlement of the public domain, under which all the remaining public lands shall be held and administered as a trust for the benefit of the whole people of the United States, and no grants of the title to any of the public lands shall ever hereafter be made to any but actual settlers and homebuilders on the land.

2. The preservation and development of our national resources by the construction of storage reservoirs by the Federal Government for flood protection, and to save for use in aid of navigation and irrigation the flood waters which now run to waste and cause overflow and destruction.

3. The construction by the Federal Government of storage reservoirs and irrigation works wherever necessary to furnish water for the reclamation and settlement of the arid public lands.

4. The preservation of the forests and reforestation of denuded forest areas as sources of water supply, the conservation of existing supplies by approved methods of irrigation and distribution, and the increase of the water resources of the arid region by the investigation and development of underground supplies.

5. The adoption of a harmonious system of irrigation laws in all the arid and semi-arid states and territories under which the right to the use of water for irrigation shall vest in the user and become appurtenant to the land irrigated, and beneficial use be the basis and the measure and limit of the right.

6. The holding of an annual Irrigation Congress, and the dissemination by public meetings and through the press of information regarding irrigation, and the reclamation and settlement of the arid public domain, and the possibilities of better agriculture through irrigation and intensive farming, and the need for agricultural education and training, and the creation of rural homes as national safeguards, and the encouragement of rural settlement as a remedy for the social and political evils threatened by the congestion of population in large cities.

Forestry and Irrigation

H. M. SUTER, Editor and Publisher

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A SAWMILL IN EASTERN KENTUCKY (SEE ARTICLE ON "FORESTRY AT BEREA COLLEGE").

Forestry and Irrigation.

VOL. VIII. APRIL, 1902. No. 4.

NEWS AND NOTES.

The Irrigation Bill. The House Committee on Irrigation on April 7 favorably reported the irrigation bill. It was the Senate bill which was reported, the House bill, or Newlands bill, as it is called, having been laid aside. The bill was amended in a number of respects so as to change several provisions which have heretofore been criticised. The measure is amended in this respect, that it provides for the more complete withdrawal of lands proposed to be irrigated by the works contemplated in order to remove all possibility of speculative enterprise. The amendment relates to lands under private ownership which may be irrigated under the provisions of the act, and provides that the owners thereof must also be actual occupants of or residents on the land referred to.

The so-called state-control clause was modified by striking out the latter portion of the section and making a substitution therefor, so that as the clause now stands it provides that nothing in the bill shall interfere with any state law relative to the appropriation, distribution, or use of water, and the Secretary of the Interior in carrying out the provisions of the act shall proceed in conformity with state laws; also that nothing in the bill shall be held to affect the rights of any state or states, or of the federal government, or of any individual in the waters of any interstate stream. This last provision simply leaves in operation the present rule of priority on the arid region.

The members of the Irrigation Committee feel sure that the bill as reported will be satisfactory to all irrigation interests. The last clause of the state-control provision is inserted with the idea of fully meeting the views of all those living in states along the lower course of streams used for irrigation purposes.

The Adirondack Park. Accurate information of the woodlands of New York, especially the Adirondacks, has long been needed. General information is abundant. Individuals have recorded their observations, and commissions have made inspection tours and issued reports of a general nature, but until recently no extensive examination of the region had been made, lot by lot, township by township.

The Forest, Fish, and Game Commission during last summer conducted such an examination of those lands lying within the imaginary blue line of the park, the work being entrusted to Mr. R. C. Bryant and Mr. Asa S. Williams, the latter kindly furnishing the following information:

"It was not necessary to examine 400,000 acres recently purchased, as the Commission had already conducted examinations of this land before the purchase was made. The land examined was classified as follows: Forest, lumbered, waste, burnt, swamp, cleared, improved, and water, state and private lands being kept separate.

"The term 'forest' was given to land still containing a good stand of spruce. Of truly virgin forest there remains but little in the Adirondacks. *Lumbered:* Culled forest with only the hardwoods remaining. *Waste:* Lands covered with an inferior growth of no economic importance. *Denuded:* Absolute waste land with no tree growth. *Burned:* Lands on which the stand was destroyed

by fire within the past four or five years. After that time it would come under the head of 'denuded.' *Wild meadows:* Grass lands uncultivated, but sometimes cut. The other terms need no explanation.

"The results of the examination were as follows:

	State acres.	Private.	Totals.
1. Forest.....	455,415	702,639	1,158,054
2. Lumbered....	592,630	1,078,509	1,671,139
3. Waste.....	10,275	38,376	48,551
4. Burned.....	14,617	28,548	43,165
5. Denuded.....	15,739	40,943	56,682
6. Wild meadows	9,961	12,568	22,529
7. Improved.....	4,642	96,338	100,980
8. Water...	60,135	64,909	125,044
Totals...	1,163,414	2,062,730	*3,226,144

"In glancing over these figures one is first struck with the enormous area of lumbered land; 52 per cent of the entire area contains no merchantable pine, spruce, or hemlock; 1,670,000 acres, with the present market and transportation conditions, have absolutely no economic value. In composition the virgin Adirondack woods contained from 60 to 65 per cent of hardwoods. The hardwoods seed more abundantly than the conifers; also the seeds of the hardwoods germinate much more readily in the heavy Adirondack duff. Given the requisite light conditions by the removal of the 35 to 40 per cent of the conifers of the stand, the result is nearly a pure hardwood growth.

"The second noticeable fact is that columns 3, 4, 5, and 6 represent absolute waste lands, amounting to 171,000 acres, or 5½ per cent of the total area.

"It is to be hoped that these figures will bring strongly before the people of the state the deplorable condition of the Adirondack region, and that more attention will be paid to the good work being done by the Forest, Fish, and Game Commission and others in reclaiming waste lands."

Summer Meeting. The American Forestry Association will hold a special summer meeting this year, during the latter part of August (the exact date has not yet been settled), in Michigan, at the invitation of the Michigan Forestry Association and of the Michigan Agricultural College. The meeting will take place at Lansing, and will probably consume two days. It will be followed by an excursion from Lansing, by way of Saginaw, to the mills at Crayling; thence to the forest preserve in Roscommon County; through the hardwood forests in northern Michigan, and thence to Mackinaw. It is possible that the trip will be extended to Marquette and the northern peninsula.

The program for the sessions at Lansing will cover the following topics:

1. A discussion of the farm woodlot—its economic and æsthetic importance.
2. Facts and figures concerning wood, posts, ties, hoop-poles, etc.
3. A symposium on the duty of the state in forest matters.
4. A discussion on the jack pine plains of Michigan.
5. Methods of starting and handling the farm woodlot.
6. Forest botany of Michigan.
7. Meteorological conditions.
8. Soil and its relation to success in forest culture.
9. The fire problem.
10. The trespass problem.
11. The question of titles.

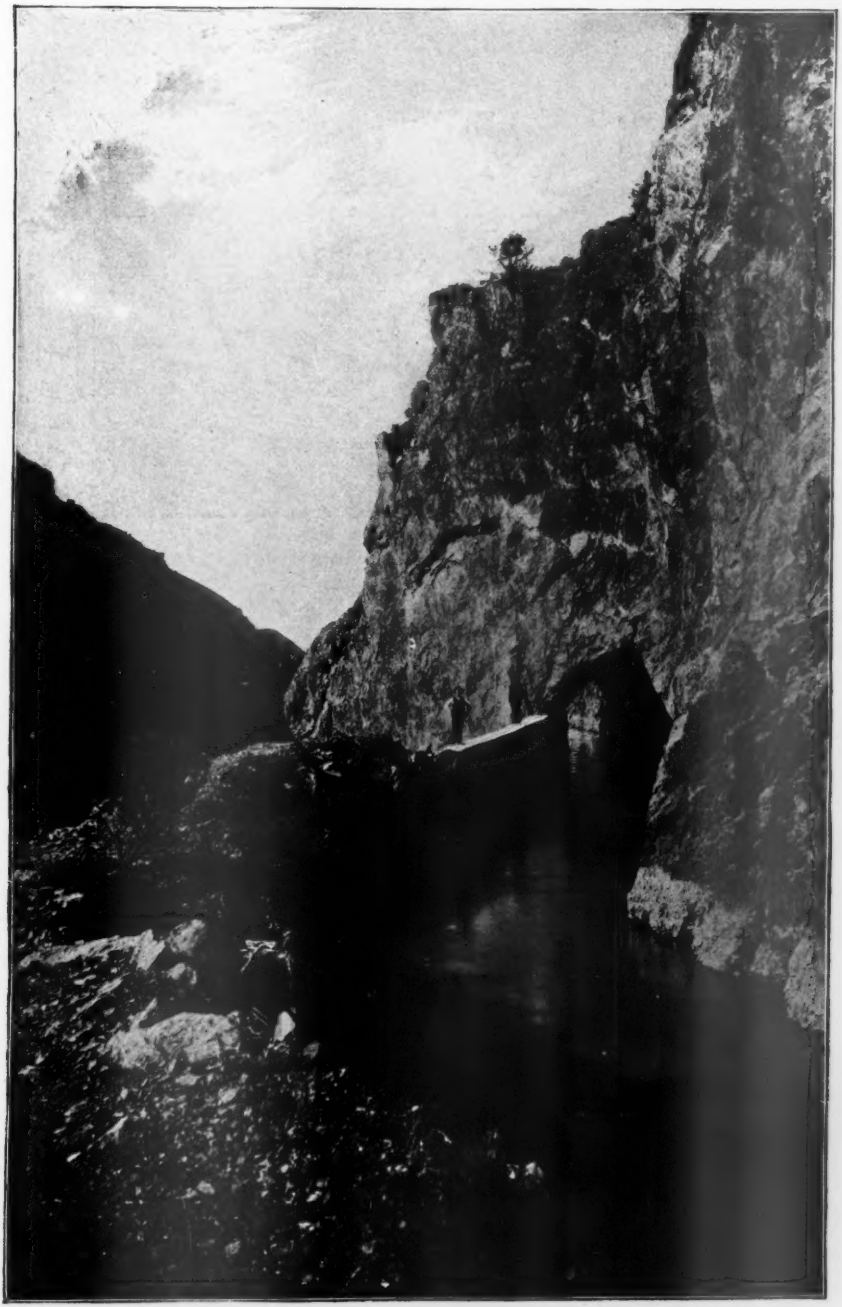
Proper Title for City Foresters. Mr. Alfred Gaskill writes us as follows concerning the proper professional title for city foresters:

"The misuse of the term 'forester' to designate a man who cares for the park and shade trees of towns and cities has occasioned some protest without bringing out a better name.

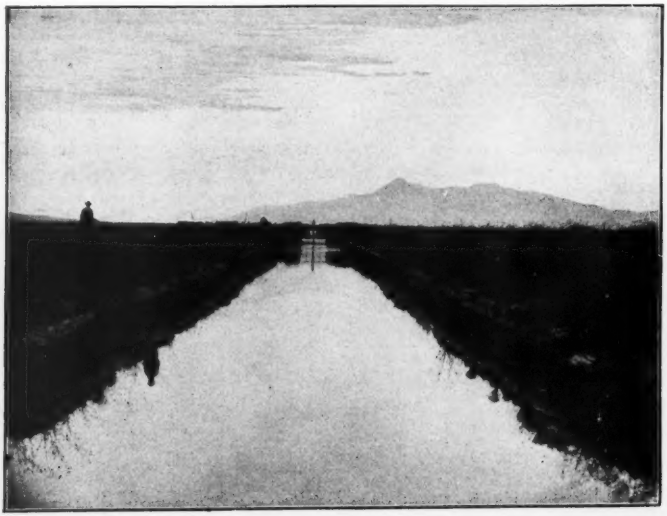
"The objection is not that 'forester' is too good or not good enough, but simply that it does not apply. A man whose business it is to look after and cultivate trees in the aggregate is a forester, while one who plants and prunes trees as individuals is something else.

"Let me therefore suggest that we have 'city arborators' instead of 'city foresters.' The word is good English, and, though marked obsolete in all the dictionaries, is capable of being revived

*Area of park.



CONVEYANCE OF WATER FOR IRRIGATION. TUNNEL OF BEAR RIVER CANAL, UTAH.



BEAR RIVER CANAL, LOOKING NORTH.

FOWLER SWITCH CANAL, CALIFORNIA, SHOWING EFFECT ON BANKS OF HIGH VELOCITIES.

SANTA ANA, CALIFORNIA, CANAL (CEMENT-LINED); CAPACITY, 240 SECOND-FEET.

and serving the present need. The Century Dictionary defines the word as 'one who plants or prunes trees,' and Worcester as 'a planter or pruner of trees;' it is therefore expressive of the worker and his work.

"A properly qualified forester is of course fitted for any position of the kind in question, and so is a landscape gardener. The plea is made for a title that will not be misleading, as that of forester in such connection is."

Effect of Deforestation. During the period from April 1 to December 31, 1901, observations of discharge and of sediment were carried on at Salt River reservoir site on both Tonto Creek and Salt River for the purpose of comparing the relative amounts of sediment contributed by the two streams. The observations on Salt River were taken below the mouth of Tonto Creek. The result of these observations shows that Salt River, below the mouth of Tonto Creek, carried .00146 of 1 per cent of sediment; while Tonto Creek, about one-half mile above its mouth, carried .00275 of 1 per cent—showing that the waters of Tonto Creek are more than twice as muddy, on an average, as those of Salt River. This is an illustration of the influence of denudation upon the discharge of sediment. The two basins are contiguous, of course—the chief difference being that Tonto basin is heavily grazed and almost bare of timber, grass, or other vegetation, while Salt River basin is mainly timbered and well carpeted with grass, it lying largely within the Apache Indian Reservation, where the sheep and cattle of white men are not allowed.

Forest Fires. On Sunday, March 25, a forest fire near Eastport, Long Island, destroyed several hundred acres of timber and required the efforts of a large force of men to prevent its spreading. Ten days later another fire broke out in the same vicinity, destroying a lot of cordwood, but was finally extinguished by heavy rains.

From Pennsylvania there have been several serious forest fires reported during the last ten days. In the vicinity of Scranton, Altoona, Oil City, and Blairsville, considerable damage has been wrought by these fires. In Maryland there were also several forest fires during the past week. Near Mount Winans, in the vicinity of Baltimore, on April 2, there was a fire that destroyed valuable timber, several barns, and for a time threatened a number of dwellings. A large amount of timber was destroyed near Cumberland during the last week in March by a fire said to have been started by the carelessness of hunters.

During the first week in April fires broke out in the cedar brakes near Marble Falls, Texas, destroying a lot of valuable timber. The pine forests near Plantersville, in the same state, have been seriously injured by recent fires. In the vicinity of Sauk Center, Minn., there were disastrous forest fires during March.

Philippine Lumbering. Mr. Asa Williams sends the following information concerning the method of exploiting timber in the Philippines: The following facts are gleaned from letters from Mr. R. C. Bryant and Wm. Klemme, both in the forest service in the Philippines:

"The Forestry Bureau issues licenses to cut timber on state lands, and payment to the government is made as follows: The timber trees of the Archipelago, six hundred and sixty-five in number, are divided into six commercial classes; each has a separate tariff at so much per cubic foot:

Superior group	14 cents per cubic foot.
First group.....	10 cents per cubic foot.
Second group.....	8 cents per cubic foot.
Third group.....	3 cents per cubic foot.
Fourth group.....	2 cents per cubic foot.
Fifth group.....	1 cent per cubic foot.

"Prices are the same in the entire archipelago. Groups three, four, and five only may be used for fuel. Needy residents may cut fuel free. The manner of exploitation is most primitive. A company, having received a license to

cut on a certain island, proceed to a point of vantage, generally a small village with a good harbor convenient. Natives are bargained with to get out the timber. They work independently, every man for himself. He goes to the woods, cuts his tree, squares it with the axe, and hauls it as he will to the coast. Here he is paid by the cubic foot. The prices are such that a good man can earn 50 cents a day. The effect of this method is to cause a belt of culled timber along the coast, while the interior remains untouched."

Sterling Irrigation Convention. The following account of the irrigation convention at Sterling, Colo., reached us too late for publication in the March number of FORESTRY AND IRRIGATION, but owing to the importance of the meeting it is printed now :

In accordance with invitations sent out by the Sterling Chamber of Commerce, delegates representing different sections of the Valley of the Platte met at Sterling, Colo., as a point most centrally located and suitable for the purpose of holding a convention on February 26 and 27, the objects of the convention being the discussion of ways and means of securing government assistance in the extension of irrigation and of finding out methods of how best the people might assist themselves and so increase their irrigated territory.

The town of Sterling is particularly well adapted for the holding of such a congress, being located at the junction of several lines of railroad connecting readily with Denver, Cheyenne, Lincoln, and Omaha and all adjacent points, and being situated in the center of an agricultural valley which has already commenced to experience the results following the introduction of agriculture by irrigation, and where it is believed that irrigation may be almost indefinitely extended in the not-distant future.

Large delegations were present from Nebraska and Colorado, the expected delegates from other states not appearing, being presumably not so deeply interested in the utilization of the waters of the Platte River as the two states represented. Prominent among the delegates from Nebraska were Governor Savage, Irrigation Engineer Dobson, and Messrs. Cox, Gardner, and Stubbs and others, including one lady delegate, Mrs. Richardson, from Lincoln. Colorado was ably represented by a large delegation, among whom were ex-Governor Eaton, former Lieutenant Governor J. L. Brush, former State Engineer John E. Field, and Messrs. H. N. Haynes, C. E. Stubbs, and others. There were also present as invited guests Hon. George H. Maxwell, executive chairman of the National Irrigation Association ; Mr. A. L. Fellows, resident hydrographer of the U. S. Geological Survey ; Mr. A. J. McCune, state engineer of Colorado, and others. The people of Sterling provided for the delegates most hospitably, furnishing accommodations at private residences after the capacity of the hotels had been exhausted.

Interesting addresses were delivered by Governor Savage, Mr. Geo. H. Maxwell, Mr. R. R. Greer, Mr. C. E. Stubbs, Mr. J. L. Brush, Mr. Chas. F. Wilson, Mr. A. L. Fellows, Mr. A. J. McCune, Mr. E. R. Chew, and Mr. H. N. Haynes.

The convention adopted resolutions favoring national construction of irrigation works, such a revision of the land laws that will make the remainder of the public domain available only for actual settlers and home-builders. The cession of public lands to the states and territories was strongly opposed, while Congress was urged to carry out at this session the recommendations of the President and Secretary of the Interior. Preservation of the forests on the public lands was also urged.

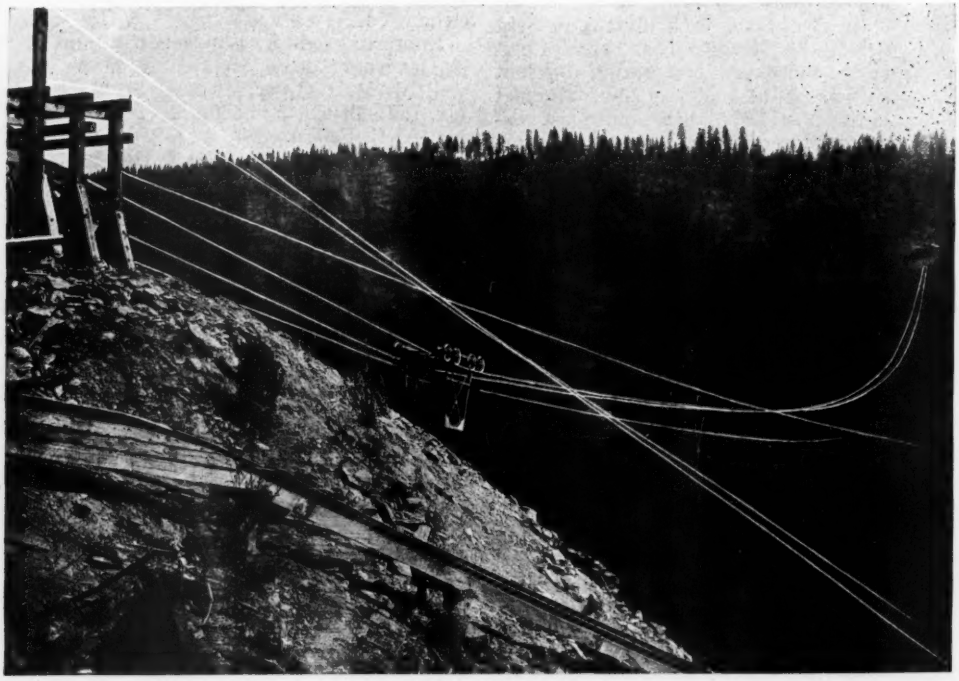
The delegates to the convention were given an excursion through the different parts of the South Platte valley adjacent to Sterling. Altogether, this was one of the most successful irrigation conventions, large or small, that has ever assembled.

Canadian Forestry Association. The third annual meeting of the Canadian Forestry Association was held at Ottawa on Mar.

6 and 7. There was much business of importance transacted, and the following interesting papers were read:

"Eastern Forest Trees Grown at Victoria, B. C., from Seed Imported from the East," by his Honor Sir Henri Joly de Lotbiniere, lieutenant governor of British Columbia; "Forestry in Ontario," by Thos. Southworth, Director of Forestry for Ontario, Toronto; "The Management of Wood Lots," by W. N. Hutt, Southend, Ontario; "The Forest Fires of 1901," prepared by instructions of the Board of Directors; "The Second Discovery of the West," by Prof. John Macoun, Assistant Director of the Geological Survey; "Tree-planting on the Experimental Farms," by Dr. Wm. Saunders, Director of Experimental Farms; "Work of the Forestry Branch in Tree-planting on the Prairies," by Norman M. Ross, Assistant Superintendent of Forestry for the Dominion; "Forestry in the Schools," by Wm. Pearce, Inspector of Surveys, Calgary, Alberta; "Forestry in Prince Edward Island," by Rev. A. E. Burke, Alberton, Prince Edward Island; "The Pulp Industry in Canada," by D. Lorne McGibbon, manager Laurentide Pulp Company, Grand'Mere, Province of Quebec; "The Management of Pulpwood Forests," by Austin Cary, Forester to the Berlin Mills Company, Brunswick, Me.; "Defects of the Pulpwood Regulations of the Province of Quebec," by E. G. Joly de Lotbiniere, Quebec, and an illustrated lecture on the "Evolution of a Forest Growth," by Dr. B. E. Fernow, Director of the New York State College of Forestry.

More Floods in the South. In the March number of FORESTRY AND IRRIGATION we published, with illustrations, two articles on the



Courtesy of "Wood & Iron."

AN UNUSUAL WAY OF TRANSPORTING LUMBER. THE LUMBER TRAMWAY OF THE EL DORADO LUMBER COMPANY, PLACERVILLE, CALIFORNIA.

disastrous flood of May, 1901, in the Southern Appalachian region. Late in March a portion of the same region was again visited by a flood even more destructive than that of last year. The following, reprinted from the Portland (Oregon) *Telegram*, is to the point:

"The recent floods in Eastern Tennessee were the most disastrous ever known in that region. About 20 lives were lost, and property to the estimated amount of $5,000,000 was destroyed. A continuous rain of 24 hours' duration was considered the approximate cause of the destructive flood. The 24-hours' downpour, in a region settled for over a century, in which time there have probably been many such precipitations, should become such a calamity and catastrophe, seems to bear with it a lesson. The first practical and useful conclusion is that the 24-hours' rainstorm was not, of itself, the cause of the destruction, or rather that, if the cause, it points to other causes. Chief among these one stands out clear and prominent—the rapid denudation of the forest areas of the higher levels of that region.

"Settlement began on the tributaries of the Tennessee even before the Revolution, and until some years after the Civil War the population was almost wholly agricultural. The forests were only cut to supply the demand for a comparatively sparse and not over-active population. Some fifteen or twenty years ago the era of industrial development began in that region. Mineral resources were investigated and exploited. Mills were built. A lumber market was found. The woods began rapidly to disappear to meet these new demands. During the last few years these demands have greatly increased in number and volume. The hills and mountains have become bare; the rainfall has decreased; but when an unusually heavy or slightly prolonged rain comes, it causes the flood that we have recently read of, whereas a century or even a quarter of a century ago such a rain would have had no appreciably evil or disastrous effects. The leaves, and roots, and grasses, and verdure generally, would have absorbed the rain, and issued it out on the sun's requisition later in the season."

This is an intelligent opinion by a writer three thousand miles away; it would seem that it is high time that the mass of people here in the East rise to the occasion. A few broad-minded men have been doing their best to bring about the preservation of this region, and it is possible that this recurrence of last year's disaster may arouse the needed interest.

Forest Work in the States. The subject of forestry has received legislative recognition in only 18 of the states, and of these the work has been abandoned in three, leaving but 15 states in which forest work is carried on at the present. These are Connecticut, Kansas, Maine, Maryland, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Oregon, Pennsylvania, West Virginia, and Wisconsin.

Adequate financial provision has been made, however, in only two states, New York and Pennsylvania, and in these work is being actively carried on. In Minnesota a good forest-fire system has been introduced, which is as effective as can be expected under the prevailing conditions. (This work is under the direction of the chief fire warden, who is deputy to the Forest Commissioner, the state auditor holding the latter office *ex officio*.) There is also a State Forestry Board, which is empowered to accept and administer for forest purposes cut-over, denuded, prairie, and other lands of very low value and unfit for agriculture. An appropriation of $1,000 is made to defray the expenses of this board, and the improvement and reforestation of the reserved lands are to take care of themselves.

Kansas has a commissioner of forestry and irrigation. Under the act creating this commission, two experimental stations have been established, one at Dodge City, the other at Ogallah. The sum of $1,000 is appropriated to carry on experiments in tree-planting and irrigation.

Connecticut has a state forester, who

is an officer of the state agricultural experiment station. The state has appropriated for two years $2,000 for the purchase of lands for a state park. In addition to this, there is a private fund known as the "Lockwood fund," from which moneys are available for forest purposes.

In Indiana forest work is under the direction of a "State Board of Forestry." The secretary of the board is state forester, and the law provides for no expenses other than the salary and office and traveling expenses of the state forester.

The state land agent of Maine is forest commissioner *ex officio*. In Maryland the forest work is under the direction of the State Economic and Geological Survey. Michigan has a forestry commission consisting of the state land officer and two other persons appointed by the governor. Two thousand dollars is the amount appropriated for the work of this commission. New Hampshire has a forest commission. Forest work in New Jersey and North Carolina is under the direction of the State Geological Surveys.

New York has a forest, fish, and game commission, and also a state superintendent of forests. North Dakota has a "state superintendent of forestry and irrigation;" Oregon, a "game and forestry warden;" Pennsylvania, a department of forestry and a forest preserve board; Wisconsin, a state forest warden.

In West Virginia the Geologic and Economic Survey is authorized to make forest investigations, but has performed no forest work, owing to lack of funds.

California, Colorado, and Ohio were among the first states to appoint forest commissions, but this work has been abandoned in all three of these states, as the legislatures have cut off appropriations. Some experimental work, however, is being done in California, under the direction of the University of California.

Death of Prominent Foresters.

Within the past few months death has made gaps in the ranks of foresters which cannot be readily filled. One after another, Hartig, Fischbach, and Lorey, leaders in forestry, whose works are standard the world over, have passed away.

The name of Hartig has been long and intimately associated with forestry. The father and grandfather of the recently deceased Robert Hartig were leading spirits in the development of forestry in their time, and their teachings and writings have been the gospel of several generations of foresters. Few American foresters who have gone abroad have failed to see and advise with Dr. Robert Hartig. He was a professor at the University of Munich from 1878 to October 9, 1901, when he died, at the age of 62.

Hardly any branch of forest science remains untouched and unassisted by Dr. Hartig. He was especially interested in the numerous questions of anatomy and physiology, and particularly in forest pathology. His researches in plant diseases brought him universal renown. He is justly considered the creator of forest pathology as we know it to-day, and he remained to the end the first authority on the subject. In 1882 the first edition of his famous "Diseases of Forest Trees" appeared, and each revision of it has brought up to date all of our knowledge of the diseases of arborescent plants.

Dr. Carl von Fischbach died in Sigmaringen November 23, 1901, at the age of 81 years. He was a practical forester and was in charge of the district of Sigmaringen, Province of Hohenzollern, at the time of his death. As an author, his reputation was extensive, especially through his widely read popular "Lehrbuch der Forstwissenschaft." By Dr. von Fischbach's decease foresters lose one of the veterans of their profession.

Dr. Tuisko von Lorey died in Tubingen December 27, 1901, aged 57 years. He was a professor at the University of Tubingen and, since 1878, editor of the *Allgemeine Forst-und Jagd Zeitung*. His great *Handbuch der Forstwissenschaft*, edited in coöperation with other scientific workers in the field of forestry, brought him a well-deserved reputation at home and abroad. Lorey was also successful as a practical forester, in which capacity he worked 20 years in Wurtemburg.

HON. FRANCIS G. NEWLANDS.

Mr. Newlands has come to be regarded as the champion of national irrigation in the House of Representatives. By his tireless activity and unremitting perseverance he has kept before the attention of the Members of the House, and of the country at large, the importance of national construction of large storage reservoirs, and of works for diverting rivers, the magnitude of which places them beyond the scope of private or even of state enterprise. He was born at Natchez, Mississippi, August 28, 1848, and entered class of 1867 at Yale College, where he remained until the middle of the Junior year. Later he studied at the Columbian Law School and was admitted to the District of Columbia bar. Afterwards he removed to San Francisco, where he practiced law until 1886, when he became a trustee of the estate of William Sharon, a former U. S. Senator from Nevada. In 1888 he became a citizen of the State of Nevada, and was actively interested in irrigation development. He was elected to the Fifty-third and subsequent Congresses, has served on the Committee on Banking and Currency and the Committee on Foreign Affairs, and is now a member of the Ways and Means Committee and the Committee on Irrigation. His most notable effort was the preparation of the so-called Newlands bill, which was introduced into the Fifty-sixth Congress, and which in substance, incorporated in the Hansbrough bill, passed the Senate during the Fifty-seventh Congress. This bill is intended to create a fund for the reclamation of the arid lands, proceeds from the disposal of the public land from the western states being set aside for this purpose. The bill is now before the House of Representatives and has received the serious consideration of various public men, including the President.

TABLE OF U. S. GOVERNMENT FOREST RESERVES ARRANGED BY STATES.

COMPILED BY THE BUREAU OF FORESTRY.

No. of reserve.	State.	Area of reserves in each state.	Names of reserves.
		Acres.	
10	Alaska.....	403,640	Afognak Forest and Fish Culture Reserve.
33	Ariz.....	1,658,880	The Black Mesa Forest Reserve.
31	"	423,680	The Prescott Forest Reserve.
13	"	1,851,520	Grand Canyon Forest Reserve.
32	"	975,360	The San Francisco Mountains Forest Reserves.
Total.....		4,909,440 acres.	
37	Cal.....	136,335	The Lake Tahoe Forest Reserve.
18	"	691,200	The Stanislaus Forest Reserve.
11	"	4,096,000	Sierra Forest Reserve.
30	"	1,644 594	The Pine Mountain and Zaca Lake Forest Reserve.
38	"	145,000	The Santa Ynez Forest Reserve.
14	"	737,280	San Bernardino Forest Reserve.
8	"	555,520	Timber Land Reserve, San Gabriel.
19	"	668,160	The San Jacinto Forest Reserve.
15	"	109,920	Trabuco Canyon Forest Reserve.
Total.....		8,784,009 acres.	
9	Colo.....	856,960	Battlement Mesa Forest Reserve.
4	"	184,320	Timber Land Reserve, Pikes Peak.
6	"	179,200	Timber Land Reserve, Plum Creek.
7	"	683,520	The South Platte Forest Reserve.
2	"	1,198,080	Timber Land Reserve, White River Plateau.
Total.....		3,102,080 acres.	
20	Idaho.....	3,456,000	The Bitter Root Forest Reserve.
21	"	541,160	The Priest River Forest Reserve.
Total.....		3,997,160 acres.	
20	Mont.....	691,200	The Bitter Root Forest Reserve.
28	"	1,382,400	The Flathead Forest Reserve.
35	"	40,320	The Gallatin Forest Reserves.
29	"	2,926,080	The Lewis and Clarke Forest Reserve.
Total.....		5,040,000 acres.	
36	N. Mex.....	*Acres.* 2,327,040	The Gila River Forest Reserve.
3	"	430,880	The Pecos River Forest Reserve.
Total.....		2,757,920 acres.	
40	Okla. T.....	57,120	The Wichita Forest Reserve.
5	Oregon.....	142,080	Timber Land Reserve, Bull Run.
16	"	4,577,120	The Cascade Range Forest Reserve.
17	"	18,560	Ashland Forest Reserve.
Total.....		4 737,760 acres.	
22	S. Dak.....	1,165,240	The Black Hills Forest Reserve.
34	Utah.....	67,840	The Fish Lake Forest Reserve.
23	"	875,520	The Uintah Forest Reserve.
41	"	86,400	The Payson Forest Reserve.
Total.....		1,029,760 acres.	
21	Wash.....	103,960	The Priest River Forest Reserve.
12	"	1,027,520	The Mount Rainier Forest Reserve.
25	"	1,466,880	The Olympic Forest Reserve.
24	"	3,426,400	The Washington Forest Reserve.
Total.....		7,024,760 acres.	
22	Wyo.....	46,440	The Black Hills Forest Reserve.
26	"	1,147,840	The Big Horn Forest Reserve.
27	"	829,440	The Teton Forest Reserve.
1	"	1,239,040	Timber Land Reserve, Yellowstone Park.
39	"	56,320	The Crow Creek Forest Reserve.
Total.....		3,319,080 acres.	
Grand total.....		46,327,969 acres—72,387 square miles.	

Total of the Bitter Root Forest Reserve in Idaho and Montana..... 4,147,200 acres.
Total of the Priest River Forest Reserve in Idaho and Washington..... 645,120 acres.
Total of the Black Hills Forest Reserve in South Dakota and Wyoming..... 1,211,680 acres.

IRRIGATION POSSIBILITIES OF THE LOWER COLORADO RIVER.*

By J. B. Lippincott,

U. S. Geological Survey.

On December 29, 1901, a party consisting of Jeremiah Ahern and the writer, hydrographers; W. B. Clapp and F. M. Barnes, field assistants, started on a reconnaissance of the Lower Colorado River between the Needles and Yuma.

A boat was built 20 feet long, 5 feet beam, drawing 8 inches of water, and square cut at each end. The boat might be called a punt. It was, however, rigged with a sail, which was found to be very serviceable on the trip, and with two pairs of oars. The prevailing direction of the winds on this river in the winter and fall is down stream, while in the summer it is up stream. It is difficult to travel up stream with a small boat, owing to the swift currents. A light-draught boat, particularly in low stages of the river, is essential to the trip, as many shoals and sand bars exist in the channel. The journey from Needles to Yuma was made in eleven days, or at an average rate of speed of a little less than 27 miles a day. Traveling could only be undertaken during the daytime, and many intermediate stops were made for the purpose of observations, hills and bluffs along the river being climbed for this purpose. The only instruments used on the trip were four aneroids, field glasses, hand levels, and hand compass. All distances and areas given in this report were estimated.

The elevation at the Needles railroad depot is 474 feet, the river opposite being probably 450 feet. The elevation of the river at Yuma is 107 feet; it therefore has a fall of 347 feet in an estimated distance of 281 miles, or 1.22 feet per mile. It was quickly recognized that aneroid observations on a stream of such light grade were of small value in comparing relative heights.

The distance on a straight line from Yuma to the Needles is 147 miles, one-half that by river. This increased river distance is largely made up by the meanderings of the stream in the alluvial valleys which prevail through a large portion of its course; consequently diversion canals having relatively straight alignments would have an available fall of about two feet to the mile.

THE BOAT.

There is a long river flat, generally known as the Mojave Valley, averaging three miles in width on the Arizona and three-quarters of a mile on the California side, containing 86,000 acres, beginning, it is stated, 10 miles above Ft. Mojave, at a point known as the "Bulls Head," and extending to the Needles, a length of

* Extract from notes made during a reconnaissance of the Lower Colorado River from the Needles to Yuma.

about 46 miles. This is good bottom land and in large part above high water.

At the Needles the mountains rise to several thousand feet on either side at distances of 10 miles from the river, offering no opportunities for extensive diversions The river at the Needles bridge, at Mellin, Arizona, was examined for a gaging station. At its present low-water stage the channels are irregular and diagonal. The bridge is 80 feet above the water and would make a poor station. Two miles below the bridge the river enters the Blue Canyon, at which point it is contracted to a width of 400 feet. If a dam 100 feet high could be placed here it would flood the large flat above the Needles. The Santa Fe railroad crosses the river at Mellin with an imposing cantilever bridge 80 feet above the surface of the stream. Boats passing up and down the river clear the bridge. A dam 100 feet high at Blue Canyon would raise the water above the floor of the bridge; the town of Needles also would be inundated. Spillway opportunities exist on the left bank 100 feet above the present level of the river. A great reservoir would be created by the construction of such a dam. No surveys were made of this site, but it is probable that a dam 100 feet high would give a reservoir capacity of over 3,000,000 acre-feet. A dam 40 feet high would probably create a reservoir some 20 miles long, flooding 45,000 acres of land and impounding 500,000 acre-feet of water. The flood stages of the river coming in May and June and filling this reservoir by the first of July, the water would not necessarily be retained therein over four months, and the loss by evaporation should not exceed four feet in depth. When this 40-foot reservoir became filled with silt, by raising the height of the dam 10 feet, 500,000 acre-feet additional capacity would be obtained. By repeating this operation the reservoir could be maintained for many years. The gates of such a reservoir should be kept open subsequent to October, when it should have been emptied, and remain open until June, so as to avoid silting above the flow line in the reservoir and permit of the scouring out of channel. In view of the existence of several reservoir sites below and of the damage which would occur from the construction of a dam at the Blue Canyon, it is

DAM SITE ON THE LOWER COLORADO RIVER TWO MILES BELOW NEEDLES BRIDGE.

believed that this valley near Needles can more profitably be utilized by irrigation from diversion canals.

It is probable that the normal water supply available from the Lower Colorado River, reaching its periods of maximum annual discharge in June and July, is more than sufficient to irrigate all available agricultural lands, and consequently reservoirs on this stream would be superfluous except for the fact that the impounding dams could be used for the generation of water power which would be of value in the valley of this stream, deprived as it is of any cheap fuel or motive power.

Below the Blue Canyon dam site for 15 miles the river is in canyon, passing through first the Blue and second the Red Canyons. Here the canyon ends and opens into the Chemehuevas Valley, which extends to within 15 miles of Bill Williams Creek for a length of 20 miles. This valley is five miles wide and would make a great reservoir site. No opportunity is seen to present itself for the extensive interior diversion above this point, the grades of the valley being very light and the sides rising rapidly beyond the alluvial plain. The area of Chemehuevas Valley is 65,000 acres. The valley is occupied by a few families of Chemehuevas Indians. They raise some stock, but no cultivated fields were observed. Below the Chemehuevas there is a narrow valley averaging a mile in width and 17 miles in length and ending at the junction of Bill Williams Creek with the Colorado River. The grade of the river through this narrow valley is light. Bill Williams Creek was flowing four second-feet of water on January 1, 1902.

The valley of this tributary near its mouth is a mile wide and flat, as far as could be observed with a hand level. It would, of itself, be a reservoir site of very respectable dimensions. One-half mile below the mouth of this tributary there is a dam site. The width of the stream at the present water level is 410 feet. A dam 60 feet high would hold back the water some 40 miles, with an average width of 2½ miles, covering 100 square miles of the Colorado Valley proper.

There are no cultivated lands or other improvements in the basin of the reservoir site, except one five-stamp mill on the right bank about 10 miles above the dam site. The surrounding country between the Needles and Yuma apparently is mineralized, and many prospects are being worked between these points. The principal difficulty encountered is that of power for the operation of the mills. There are one or two houses near the mouth of Bill Williams Creek, and at Empire Flat, below the dam site, there are some comfortable-looking dwellings. The distance from Bill Williams Creek to Empire Flat is 14 miles, and from Empire Flat to Parker, the agency for the Colorado Indian Reservation, it is 15 miles.

From Empire Flat to Parker the river is in a narrow valley with little irrigable land. The Colorado Indian Reservation extends from Monument Peak to Ehrenberg. The distance from the agency at Parker to Ehrenberg is 59 miles. The bottom lands are almost entirely on the Arizona side of the river, and between Parker and Ehrenberg lie mostly within the Indian Reservation. There are said to be some 300 to 400 Indians located here, but no agricultural developments of any magnitude were noticed. A canal heads on the river two miles above Parker, but its present intake is too high to divert water at the present low stage, and a subsidiary pumping plant lifts water into the canal. A few feeble attempts at irrigation were observed near the pumping plant. A wagon road is now being constructed from the Needles to Parker, the distance being 70 miles. Water may be had at a half-way point.

To the west from Parker and on the California side of the river there is a pass that possibly might be reached with a dam 100 feet high at Bill Williams Creek, and a canal 50 miles long. This, however, is extremely doubtful. It was impossible to determine these relative elevations without extended surveys.

A prominent peak, known as Riverside Mountain, is 20 miles by river below Parker and 12 miles in a straight line. At a projecting point on the Ari-

SCENE IN THE VALLEY OF THE LOWER COLORADO RIVER.

zona side, 1½ miles above Parker, and favorable for a diversion, there is a tunnel located so as to divert irrigation water for the agency, as noted above. On the right bank, at this diversion point, the land is low for a quarter of a mile, the distance not being definitely determined. A wooden framework weir, such as is used on Kern River, California, lifting the low water 10 to 15 feet, would command a good tunnel-diversion site, and such a canal would cover the entire flat between Parker and Ehrenberg.

Twenty-seven miles below Riverside Mountain, on the right bank, there is a point of black rocks where the valley, on the Arizona side, is four miles wide. Below the sides of the valley recede on the California side, offering a good site for a diversion headworks, though the bottoms on the left bank are low and wide. Below, on the Arizona side, the valley continues 12 miles wide to a place where the low gravel mesa-like hills approach to the river above Ehrenberg. This valley, between Parker and Ehrenberg, is 45 miles long and 6 miles wide in Arizona, containing 270 square miles, or 170,000 acres, all of which could be put under an irrigation canal, diverting water from above Parker, as noted above. There is enough more bottom land in California in the reservation to bring the total area of bottom land to 200,000 acres. The valley on the California side, beginning at the point of black rocks 12 miles north of Ehrenberg, quickly attains a width of five miles, and at Ehrenberg is from 10 to 12 miles broad. The Blythe estate has obtained title to 42,000 acres of the north end of this California valley, and is using it for a stock ranch. Surveys are now being made for the reclamation of some of this land.

This great valley, called by Lieutenant Ives the "Great Colorado Valley," is undeveloped and is little used, even for stock-raising. Ehrenberg, containing half a dozen adobe houses, is the only settlement between the Needles and Picacho, a distance of 241 miles by river. Six miles south of Ehrenberg, where a gravel hill 200 feet high projects into the left bank of the river, observations were made and a number of photographs taken.

The valley on the California side is 10 miles wide and extends from the point of black rocks 12 miles above Ehrenberg to the south as far as the big bend of the river near Picacho, California. On the Arizona side, below

the point of observation noted above, the valley again opens and maintains a width of two miles as far as could be observed to the south, but looks quite low.

The reconnaissance was continued on down the river to Picacho, no points offering opportunity for extensive interior diversions being noted until the river finally leaves the last of its mountain canyons some 10 or 15 miles below the town. About 20 miles above Picacho the river encroaches on some bold rocky bluffs on the right bank, but the bottoms are about a mile wide on the left side. The river here starts its big bend to the east. These are the first rocky banks encountered below Ehrenberg. If any long tunnel diversion from the river is to be made towards the Salton Sea country in California, it probably could best be done here, but from the data now available this is not believed to be feasible, as it probably would require a tunnel of fully 20 miles in length. One mile below the above-described rocky cliffs, at a place indicated as Norton, Arizona, on the land-office map, the river runs between porphyry hills. The rocks come down to the water's edge on the east side of the river, but the distance between the walls is fully 1,800 feet. Spillways on the side are available. Diversion lines on either side of the canyon would be quite expensive and difficult, and the site does not seem suitable for a cheap dam.

Two and a half miles below Picacho the river again passes through cliffs of porphyry. The distance between the walls at the water level is approximately 700 feet. Spillway opportunities exist on the California side. This is the last canyon on the Colorado River. It is a dam site of considerable merit and probably the most available for extended diversions of the lower river to the east and west of Yuma. It is the best initial point for surveys to determine irrigable areas.

It is believed that the water supply of the Lower Colorado River is normally greater than would be sufficient to cover all areas irrigable therefrom.

Twenty miles above Yuma, on the Arizona side, is a valley of about five square miles. These small valleys continue intermittently until the valley of the Gila is reached, a few miles above Yuma, on the Arizona side, and the lands of the Yuma Indian Reservation are encountered on the California side. A point known as the "Pot Holes," about 14 miles above Yuma, which frequently has been referred to by others as a suitable diversion point, consists of low granitic mountains on the right bank and of some low buttes on the left. The distance between these rocky walls is at least 6,000 feet, and the river is now well within the center of this opening, though old channels indicate that at a recent period the river was close to the California side. The situation does not seem well suited for diversion purposes. Below the "Pot Holes" broad river bottoms open out on either side and contain probably 60,000 to 80,000 acres, above Yuma, of high-grade lands.

The bottom lands described in this report are covered with a dense growth of Willows, Cottonwood, Mesquite, and smaller brush down to the water's edge, the same being so dense as to make it difficult to find camping places. Back a mile or so from the river the brush is less thick, but a small shrub, known as Arrowroot, there takes its place. The mesas and the mountains back from the bottoms are almost entirely bare either of brush or grass.

The soils in the bottoms are generally good, consisting of fine river silts containing a low per cent of alkali in the form of lime compounds.

The river meanders through these bottoms, frequently changing its channels and cutting down and building up the flats. Within half a mile of the river they seem to be subject to overflow at the annual high stages of the stream. It probably would be possible to plant crops which could be harvested before the high stage of the river, and other crops after its recession. Probably these overflow conditions would result in advantage rather than disadvantage to cultivated fields, as a new layer of soil would be deposited with each high water. The greater portion of these bottom lands nearer to the foot-

hills would not be subject to overflow or encroachment, but those portions near the river, if farmed, would have to be protected, as in the case of the Missouri and Mississippi bottoms. This, however, would only be necessary after the outlying lands have become utilized, and as further experience with the river has developed its characteristics and the necessities in the situation.

The river water is always muddy, the percentage of silt being much greater in the high spring and early summer stages of the stream. Mr. H. Hawgood, a civil engineer of Los Angeles, California, has reached the conclusion that the Colorado River carries enough silt per annum to cover 100 square miles 6½ feet deep. He determines this both by laboratory tests and by a long series of records kept in the settling basins of the pumping station at Yuma.

The water is not of a very high grade for domestic and irrigation purposes, but it cannot be said to be a bad water, and is of a higher grade than the water of the Gila or the Salt Rivers. The handling of the silt in the canals is probably the most serious problem in connection with the irrigation from this stream. It is believed, however, that if the water is conducted in the canals at as high or higher velocities than it is in the river at the point of diversion that this difficulty might be avoided.

Temperatures are high in summer, frequently 110° to 120° Fahr., but probably they are no more severe than those at Phœnix or Yuma, Arizona. It is believed that the summer heat of the Colorado Valley is no more oppressive than that of the great central valley of California, as at Bakersfield, Fresno, or Red Bluff, or in the southeastern portions of the United States. Palm trees were observed growing at Parker, Arizona, and the winter climate can be described as semi-tropic. The growing season would extend practically throughout the year, and it would be possible to cut from 6 to 8 crops of alfalfa annually. During the expedition in January, 1902, the weather was perfect for camping without tents.

The Colorado River, draining 225,049 square miles, and receiving its principal water supply from Colorado and the high mountains of Utah and Wyoming from the melting snows, attains its maximum annual flood stage, about

VEGETATION ALONG THE LOWER COLORADO RIVER.

2,500,000 miner's inches, during the month of June. The river gradually decreases in volume through the late summer and fall, reaching its lowest stage, about 200,000 miner's inches, at midwinter, during the cold weather period of the high mountains.

This water supply is particularly adapted to the demands of irrigation, as the period of greatest supply is coincident with that of greatest demand, and, conversely, the low stages of the river are during the season of the year when plant life is least vigorous and the demands of irrigation are not so great. The river probably can furnish an abundant supply of water to fully irrigate 3,000,000 acres of land, which is probably a greater area than can ever be commanded in the United States by canals from this stream.

The boat used on this expedition, drawing eight inches of water, grounded on sand bars on every day of the trip. A stern-wheel iron steamer, drawing 12 inches of water, five days out from the Needles, was passed 10 miles south of the town. The river (January, 1902) was unusually low and the conditions unfavorable for navigation. However, when high stages occur, the velocities of the water increase to six miles an hour, and are difficult to overcome in going upstream. Two steamers ply on the river from Needles to the Virgin River, the Montezuma, and the Gila. Steamers have been running on the river since 1852, and most of the heavy transportation to the mines is done by them. They would probably be abandoned as soon as railroads entered into competition with them. The uses of the river for navigation would be small compared to the benefits derived from its application for irrigation.

In conclusion, it may be stated: First, that fully 500,000 acres of river bottom lands between Needles and Yuma are easily irrigable from the Colorado River; second, that quite possibly extensive interior diversions could be made for the reclamation of larger areas of arid lands near Yuma; third, that reservoir sites exist at the Needles, above Bill Williams Creek and above the Picacho dam site; fourth, that reservoirs for impounding flood waters for irrigation probably are unnecessary on the stream; this to be determined by further study of the water supply and of the areas of irrigable lands; fifth, owing to the low grade of the stream and the high percentage of silt carried by the water, diversion weirs probably will be necessary to raise the water level at the head of the canal and to act as settling basins therefor; sixth, that the mining resources of the bordering mountain ranges are of such character as to justify the belief that a general population and development of the country will result in an extended mining industry in this great interior valley; seventh, that the problem of the most extensive and economic use of this river is entirely too vast to be grasped, either by a reconnaissance survey or even by numerous independent line surveys, and that the only possible or practicable way of solving the problem is by the aid of a series of topographic maps extending from the Mexican border up to Ft. Mojave.

FROST CHECKS AND WIND SHAKES.

By Eugene S. Bruce,

Bureau of Forestry.

THE relation between frost checks and so-called wind shakes in timber is not generally understood by many people who are greatly interested in both trees and timber. My attention was first called forcibly to this subject by noticing the marked difference in sound between the clear and sharp crack of the trees when frost was going into the timber, after a spell of warm weather, and the rather dull, muffled, and confined chug, when the frost was leaving them, and the temperature was rising rapidly.

For a number of years it was neces-

sary for me, in attending to the details of the lumbering business in which I was engaged, to travel through the Adirondack forests a great deal of the time, more especially in winter, and I have often been startled by the sharp, whip-like crack of a tree within a few feet of me.

Actuated by a desire to know just what caused the marked difference in sound when frost was going in or coming out of the tree, and what effect the sudden changes had on the timber, I have for a number of years been studying this subject in different localities and at different elevations. As a result I have come to the conclusion that the greater part of the so-called wind shake in timber is in reality primarily caused by frost checks.

FIG. 1.—SHOWS EFFECT OF A CONTRACTION FROST CHECK UPON SPRUCE.

The so-called wind shake is much less noticeable in warm climates, there being but a small amount when compared with those localities where the timber is subject to sudden extremes of heat and cold. Neither are frost checks or wind shakes as plentiful, nor their effect on timber as damaging, in the country farther north, where it is at times extremely cold, but where the changes from one extreme of temperature to the other are more gradual, as they are in these degrees of latitude where there are lesser extremes of heat or cold, but with much more rapid transitions from one extreme to the other. These facts are a very strong argument in favor of the theory that the wind shake is primarily a result of frost.

Checks caused by the frost when going into a tree have almost invariably been found to extend in a perpendicular direction up and down the trunk, invariably following the grain of the wood as it would split with an axe. In looking for the reason for this, it becomes apparent that these checks in the wood are caused by the sudden contraction of the outside of the tree, brought about by intense cold.

The long, straight gum seams, especially noticeable in spruce timber, often found above the middle height of the tree, are almost invariably caused by contraction (Fig. 1). Such checks once opened, are afterward kept from closing and becoming solidified by the action of the wind on the top, in working the tree to and fro; also by extremes of high and low temperatures quickly following each other.

In succeeding changes from a high temperature, the check being the weakest point in the tree trunk's surface, is the first to give way under the influence of contraction. From the check thus made gum exudes and is pressed out to the surface of the tree by the contraction and expansion, or opening and closing of the seams. This gum forms along the seams in globules or lumps, which are hardened by exposure.

The action of frost when going in and out is almost exactly opposite in its effect on trees. When frost is going into a tree the outside rim or surface commences to contract, and if there is a sudden change from a high temperature to an extremely low one, the outside layer contracts more rapidly than the inside layers of timber for the reason that the outside is directly exposed to

FIG. 2.—SECTIONAL VIEW OF THE EFFECT OF A CONTRACTION FROST CHECK.

the intense cold. The timber inside, of course, contracts also just as it receives the effect of the cold. Being protected by the outside layer, it contracts much less rapidly.

The results of this more rapid contraction of the outer layers of the tree are in a general sense the same as when a machinist or blacksmith attempts to shrink a heated iron band upon a cold, solid shaft. If the band is large enough to go on easily when heated, it will contract when cold so as to become practically a part of the shaft; but if the band is tight when placed on the shaft, the solid shaft being too strong to allow the band to shrink or contract beyond a certain degree, the result is that the band is rent in twain by its own force of contraction.

This well-known principle in physics applies to the shrinking of wood under the influence of frost, for as the outside layer of the tree becomes more and more contracted by the influence of intense cold, it closes more closely on the warmer wood inside, and as that portion of the timber is being contracted much more slowly, it offers more and more resistance to the sudden and rapid contraction of the outside rim. The result can easily be foreseen: the timber outside being unable to withstand the strain, splits or checks with a crack like a pistol shot for a distance up and down the tree sufficient to relieve this strain (Fig. 2). Some checks extend the whole length of a tree. Such checks very rarely solidify or grow together again, but are kept open by the action of the wind and the effect of repeated expansion and contraction caused by extremes of temperature.

As stated above, the effect of the sudden expansion of a tree caused by a rapid change from a low temperature to a higher is exactly the opposite from the contraction, but with no less serious

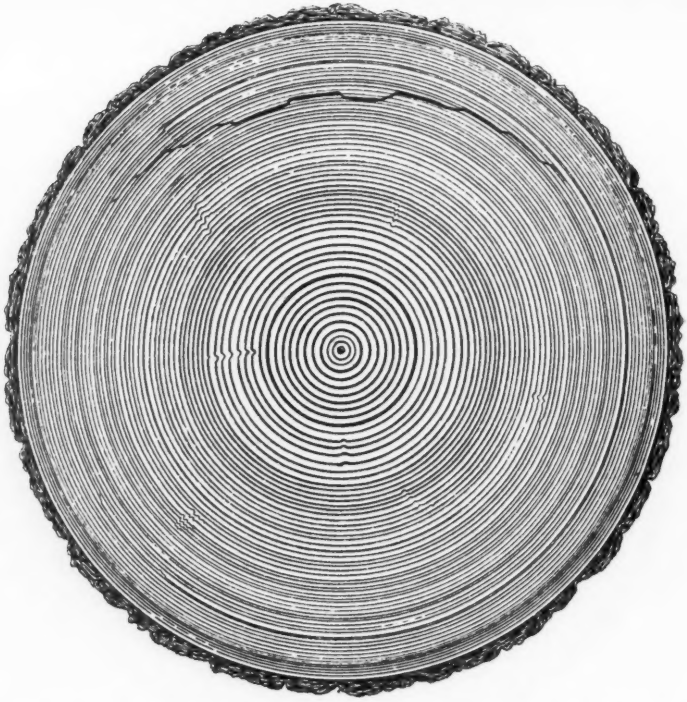


FIG. 3.—SECTIONAL VIEW OF AN INTERIOR FROST CHECK CAUSED BY EXPANSION.

FIG. 4.—SECTIONAL VIEW OF AN EXPANSION FROST CHECK OPENED TO THE SURFACE BY A SUCCEEDING CONTRACTION CHECK.

damage to the value of the timber in the tree. When frost is leaving a tree on account of rapidly rising temperature, the outside layer is again the first to receive the effects of the sudden change, and first commences to relax its contraction and expand under the influence of the rising temperature. If the change from a low temperature to a higher one is very sudden, the outside rim expands so much more rapidly than the inside growth of timber that the sudden expansion causes the outer layer to break or tear away from the colder and more slowly expanding layers of wood inside. The report of the check or separation gives out a muffled or deadened sound, instead of the clear-cut, whip-like crack of the contraction check.

Frost checks of this description occur chiefly in the trunks of trees, in that portion near the roots where they are least protected by foliage or branches from the action of the sun. Frost checks from expansion are most frequently found on the south side of trees where they receive the unobstructed rays of the sun, after having been subjected to a very low temperature for a sufficient length of time to contract them to their smallest diameter.

Expansion checks nearly always extend in a circular direction, following and opening up along the annular rings. They often connect with some contraction, since an open check caused by contraction is naturally the weakest portion of the tree from which a circular or ring check could start, and the timber would give way there first.

Expansion checks do not necessarily show on the surface of a tree, however, as I have found at different times by examining a tree after hearing it emit a muffled snap when the frost was leaving the timber. Not being able to find any perceptible check showing on the surface, I have had the tree cut for the purpose of ascertaining the effect on the timber, and in such instances have found an open ring check extending in a semicircle around the tree with no opening to the surface of the tree, as shown in Fig. 3. Such checks, however, are usually split open to the outside surface of the tree by the next sudden contraction, as, on account of this ring checking, that portion of the tree is weakened and thus becomes the more susceptible to the strain of contraction (Fig. 4).

The movement of the tree, caused by the action of the wind and repeated contraction and expansion afterward, keeps these checks opening and closing, and causes the inner portion of the tree, where the checks exist, to become exposed to the air and the action of the elements. As a natural result, decay sets in, after which there is no possibility of *those affected portions* of the checks ever growing together solidly. It is in this manner that much of the so-called wind shake and ring rot is started. These phenomena are particularly noticeable in coniferous species, which are the ones chiefly affected by frost check, as all people experienced in cutting timber are aware. Frost checks are noticeable in the broad-leaf trees,

FIG. 5.—THE EFFECT OF A CONTRACTION FROST CHECK UPON BIRCH.

but in a less degree than in the conifers. The general effect of frost is the same in both classes of timber (Fig. 5). The more difficult the timber is to split, the less likely it is to be affected by the frost, either by expansion or contraction.

It is noticeable that frost checks from expansion are most frequent in the timber standing on the south side of hills or mountains. Trees standing on the north side of hills and mountains are found to be much less affected by expansion or ring checks, on account of being protected by the intervening elevations from receiving the direct warming influence of the sun, consequently expanding more gradually.

PROPOSED NATIONAL LEGISLATION.

EXTRACT FROM THE REPORT OF THE INDUSTRIAL COMMISSION ON IRRIGATION.

WHY NATIONAL AID IS ASKED.

NATIONAL aid is not asked to secure the beginning of the work of irrigation nor to take up an experiment. Many millions have already been spent by private enterprise. The main object of national assistance is to make it possible for the people of the country to continue to secure homes upon the public domain through the ability to obtain water, to be brought ultimately to the land by ditches or conduits built by themselves. It is asked for the same reason that the settlers called upon the government to protect them from the Indians; that works are built to prevent overflows of great rivers, and navigation aided by establishing light-houses, and sometimes rendered possible by dredging a bar across the entrance to a harbor. As before stated, none of these pay, in the sense of a commercial undertaking, but the government and the people as a whole secure a larger share of prosperity through thus making possible increased opportunities for commerce and industry.

The national government has already begun in part the work of reclamation by setting aside the summits of the mountains from which issue the rivers most important in irrigation, and creating these into forest reserves for the beneficial influence exercised upon the stream flow. It is necessary to go still further, and within these forest reserves to build reservoirs, saving the floods and regulating the flow of the streams. These should never fall into private or speculative control, but should be administered for the benefit of various communities, situated often in different states.

NATIONAL CONTROL PREFERABLE.

There is no doubt that any extensive plan for the reclamation of arid lands can be carried on to much better advantage by the general government than by the states which have such lands within their borders. Where the lands have been granted to the states they have been improvidently disposed of, and private individuals have ultimately acquired ownership of large tracts, as many as 14,000 acres in one instance. In every case where work of reclamation was a national enterprise it was a success, and only when relegated to the state has it proved a failure. The national government, the original owner of the land and still the possessor of the greater part of it, alone has the right and the ability to conserve the waters for the best interests of the several states and communities.

In California 43 per cent of the land belongs to the United States or is reserved and not subject to taxation; in Colorado, 60 per cent; in Idaho, 83 per cent; in Montana, 83 per cent; in Nevada, 88 per cent; in Utah, 83 per

cent, and in Wyoming, 81 per cent. The people of the United States own from three-fourths to nine-tenths of all the land in the far West. They have as owners rights in the states there which the states themselves do not possess. The states sometimes have the taxing power over only small fractions of their area. The people of the United States are supreme in their control, and in all patents for lands taken up under any of the land laws of the United States after 1890 a reservation is made for a right of way thereon for ditches or canals constructed by authority of the United States.

This policy of national control has been recognized in foreign countries. From time immemorial Egypt has maintained her entire population on lands that Egypt reclaimed as a national enterprise, and by so doing in ages past gained the title of "the granary of the world." In India 26,000,000 acres of land have been reclaimed by the government as a national project.

Having decided that the policy of government aid may be safely begun, the laws enacted should be framed to prevent miscarriage. The money of the people should be spent for the development of future homes, and not to foster or protect land monopoly, and appropriations so safeguarded as to secure this result.

Private proprietorship of water should never be recognized, because ownership thereof virtually carries with it control of the land; but the rights of each person who can put a certain amount to use should be clearly defined and guarded in the order of priority, beneficial use alone being the measure and the limit of the right.

The primary object in asking that action be taken by the federal government is that land monopoly may be prevented. By limiting holdings to 80 acres each as a maximum, it will be extremely difficult to create a monopoly of ownership.

The requirement of actual settlement and cultivation, coupled with payment of the cost of storing water, will also eliminate the speculative element and reserve the lands for *bona fide* settlers.

RIPARIAN RIGHTS.

The laws and customs governing riparian rights in the humid and semi-humid portions of the country have been modified or made of no effect in most of the states and territories lying within the arid region. It is there recognized that water is part of a common stock necessary for life and industry, to be drawn upon by all in accordance with certain orderly procedure. Most of the arid-land states have, therefore, in their constitutions, abrogated the old doctrine of riparian rights; so that it is no longer the law in those states that a stream shall flow "undiminished in quantity and undefiled in quality" past a man's land. It can all be appropriated and diverted, and he may be left nothing but the channel. That provision of the state constitutions has been upheld by the state courts and by the Supreme Court of the United States.

The laws in the different states of the arid region differ widely, but there are certain underlying principles which are being established by court decisions, and through these many of the complications are being satisfactorily solved. The conditions which arise where a stream crosses state lines are, however, beyond the control of local legislatures and must come within the cognizance of Congress.

In Colorado, Wyoming, Utah, Idaho, and Montana the waters of streams are under public control, more or less strict, and there is also a practical uniformity in irrigation methods and similarity in the general character of the water supply, climate, and soil. This territory also includes some of the states which have by constitution and statute abrogated the common-law doctrine of riparian rights.

DIFFICULTIES AND COMPLICATIONS.

The question of national aid in irrigation has brought up certain inquiries regarding relations between the individuals who own water rights, the state which has a certain control over these, and the nation—the great land-owner and source of titles to the land and of

rights to the water. The matter at first sight presents numerous complications, but underlying it are fundamental principles which are being developed by custom and sustained by decisions of the courts.

Private enterprise has already gone nearly to its full limit. State action has been confined almost wholly to attempted improvements in legislation and the control of the distribution of the water among the irrigators. National works are being urged by those who have most thoroughly studied the subject, upon the ground that the nation alone is in a position to conserve the water supply, since it controls the land and the sources of most of the important streams. It is not suggested that there should be any interference with vested rights, nor with the distribution of water to the irrigators by state officials, wherever such exist. Under any suggested combination of interests in reclamation, the nation must construct the reservoirs, the large tunnels, and diversion works from great rivers, the experimental deep or artesian wells, which demonstrate the existence of underground supplies in desert areas, and other works the magnitude of which entails cost too great for private enterprise or too far-reaching for state action. In harmony with this general development, and within its own borders, each state can supplement the national work, as far as this may be of local concern, and regulate all matters such as the adjustment of disputes among irrigators and the harmonizing of conflicting local interests.

There has been a tendency, also, to magnify the difficulties and complications and the large expenditures which ultimately may result from national reclamation works, but it is neither necessary nor desirable to attempt to foreshadow them. The magnitude of the work to be done is doubtless fully realized by the Congress. The hydrographer of the United States Geological Survey suggests an expenditure of $125,000,000, spread over a period of twenty-five years. Another estimate is for $10,000,000 a year for ten years. In any event the ultimate amount needed, while not prohibitive, will be large enough to demand the utmost caution and wisdom in the provisions made for beginning and continuing work, so that the good to be returned to the people at large shall amply repay and justify even the largest amount of expense probable or necessary for the successful completion of the great undertaking. Whatever the ultimate expenditure for reservoirs and main-line canals, the return in money and indirect benefits will be still greater. Congress need not now consider remote expenditures and returns, but certain present concrete matters on a business basis.

ANSWERS TO OBJECTIONS.

There can be no possibility of conflict between the state and national authorities over water rights when once it is clearly established that beneficial use alone governs the right to water. Those now thus employing the water are doing so under the law of Congress of 1866, and their rights are and will be fully protected. The states, in some instances, have created certain machinery for adjusting disputes among these users of the water, such disputes as must always arise when men are drawing from a common stock; but the purpose of no state can be otherwise than to guard the waters and divide them justly among the various claimants.

The nation is the great land-owner and holds the water as part and parcel of the public land, allowing those persons who have put it to beneficial use to do so under set regulations, mainly of the nature of police control. It is not believed that the nation has divested itself of the unutilized waters of the public domain. If this were the case, the lands would be deprived of value and the government would be more helpless than an individual owning an equivalent area. It is not necessary for any state to divest itself of its police powers nor of its authority to adjust difficulties among its citizens as to water rights, nor is it necessary for the government to create additional machinery and a new set of officers to perform duties now undertaken, theoretically at least, by state officials.

While uniformity of practice regarding distribution of water might be desirable, yet throughout the arid region it is not an essential, since local conditions are so different. For example, methods and machinery may be used in Arizona to maintain a reservoir and divide its waters entirely different from those used in Montana, and yet the results for the people of both states be equally satisfactory. Certain general principles being assured, there is no reason why the laws and regulations of Arizona should be identical with those of some northern state.

To all these doubts and difficulties and fears of trouble and complications the same reasoning may be applied. From the best knowledge obtainable, it would seem to be neither feasible nor advisable to attempt in advance to bring about ideal conditions. If, as proposed in the legislation under consideration, the Congress adopts the proviso that right to the use of water acquired shall be perpetually appurtenant to the land, and that beneficial use shall be the basis, measure, and the limit of the right, and, further, that the distribution shall be in accordance with local laws and customs, the anticipated complications will gradually adjust themselves.

PRELIMINARY WORK ALREADY DONE.

All intelligent legislation is best promoted when based upon full knowledge, and an enterprise so vast in its ultimate magnitude should be undertaken only after thorough study of present conditions and future needs. The actual work of construction of reclamation projects should be entered upon only after a full knowledge has been gained of the cost and benefits of each, and every individual scheme should be considered solely upon its own merits and its relation to the full, ultimate development of the country.

DEFINITE PROJECTS READY FOR ACTION.

Certain definite, well-matured projects, with their costs and benefits, have been fully considered. If these are proper, they should be built, and when other projects are known to be feasible, they, too, should be weighed carefully and decided upon the merits of each case The next Congress and the next generation of legislators and engineers will probably be as wise as the present, and can manage with equal ability. Out of the large number of projects examined, which undoubtedly should be built by public funds—surveys, plans, and estimates therefor having been prepared—may be mentioned the following: The San Carlos storage reservoir in Arizona, reclaiming 100,000 acres or more of public land at an estimated cost of $1,040,000; the construction of reservoirs in the Sierra Nevada in California for reclaiming desert lands in Nevada; the diversion of St. Mary River into the headwaters of Milk River, in Montana.

Of one of these the Secretary of the Interior, in his latest annual report, says:

"If it should be determined that the San Carlos dam, for example, is to be built by the government, every acre of vacant land to be supplied with water would be immediately taken in small tracts by men who would not only cultivate the ground when water is had, but in the meantime would be available as laborers in the construction of the works, and would ultimately refund to the government the cost of the undertaking."

RECOMMENDATIONS OF COMMISSION.

We recommend that the Congress enact laws:

1. To provide for national control of sources of water supply upon which two or more states may depend for irrigation.

2. To provide for further comprehensive surveys of the arid lands of the United States, and for an immediate estimate of the water supply available for reclamation thereof; for the construction of storage reservoirs and irrigation works by which to utilize the water supply of the arid regions to the greatest possible extent; to reclaim said arid lands of the United States, reserv-

ing control of the distribution of water for irrigation to the respective states and territories, and the holding of such lands for actual settlers under homestead entry.

3. To provide for beginning the construction of one or more large reservoirs or diversion works where the results of surveys and examination have shown that vacant public lands can be reclaimed, such land, at the conclusion of the work, being thrown open to homestead entry only, with the condition attached of actual settlement and cultivation of the ground, final title to pass only when the government has been reimbursed by small annual payments, if necessary, for an amount equivalent to the cost per acre of conserving the water.

TEACHING FORESTRY AT BEREA COLLEGE.

By S. C. Mason,

Professor of Horticulture and Forestry.

BEREA COLLEGE is located in south central Kentucky, just outside of the famous blue-grass region and at the beginning of the picturesque foot-hills or knob country which introduces the mountains proper. It is a region of great variety in rock formations, soils, and exposures, and originally was clothed with a mixed hardwood and coniferous forest growth scarcely surpassed for variety of species and quality of timber in any part of the South.

PINUS ECHINATA AND PINUS VIRGINIANA, 42 YEARS OLD, NATURAL REGENERATION, BEREA COLLEGE FOREST PRESERVE.

While the forests convenient to shipping points have been severely cut into and the most of the "Poplar" or Liriodendron within reach of streams has been run out, much of the heavier timber of excellent quality still remains standing only a few miles back, and almost all kinds of forest operations connected with the utilization of timber may still be found in active progress.

Such conditions make it possible for the Forest Department at Berea College to combine class-room instruction with field observation and practice within daily reach of the student. For the furtherance of this end, as well as to secure an assured timber supply for college use in the future, a tract of over a thousand acres of mountain land has been purchased. The most of this land has been lumbered over, though now well stocked with young growth, while portions still contain old oak and pine of the first quality.

This tract is being added to from time to time as the means can be secured, for it is believed that at the present low prices of this class of land such endowment will, in future years, prove a sound investment, financially as well as educationally. Just here it should be said

RAFTS OF YELLOW POPLAR.

that Berea is indebted chiefly to a number of generous women, and to one in particular, for the means to purchase this little demonstration forest and to preserve the beauty of a very picturesque tract of country.

The college does not at present maintain a distinct school of forestry, but only a department, offering, first, three terms' work in the college course; second, a term's elementary work in the "Applied Science" course in agriculture; third, a winter course of familiar talks or lectures to the preparatory students.

In the college work, Course 1, Dendrology is given in the fall term and a study is made of the most important American forest trees in their botanical classification, soil preference, geographical distribution, and economic importance. The occurrence of over forty native species of trees upon the college campus and farm, and as many more

VIEW IN BEREA COLLEGE FOREST PRESERVE.

within collecting distance, enables the student to lay down a foundation of tree knowledge which must be the basis of intelligent forestry. To the student who does not expect to follow forestry as a profession, such study will afford an ever-fertile source of recreation and pleasure in after life; and the more enlightened and enthusiastic tree lovers our American people become, the better the prospect for wise legislation on forest matters.

Course 2 takes up the subject of forest influences on climate, soil formation, stream flow, stem analysis, forest mensuration, and forest finance, followed by a study of some of the local forest products, as stave and spoke stock, railroad ties, or shingles. Careful data is gathered as to the age and quality of timber demanded for the products, yield, and methods of exploiting.

VIEW IN PINE AND WHITE OAK "FLAT WOODS" AFTER LUMBERING.

Course 3 takes up silviculture and forest management, making a special study of the conditions under which natural regeneration of the native species takes place. The local forests and old field growths afford many fine examples for this line of study.

The single term of work in the agricultural course is designed to give the young farmer the elementary ideas of the value of forests to the community, their protection and care, and how to make the most of the timber tract or woodlot that may come under his management. This short agricultural course also comprises, besides the more strictly agricultural branches, two terms of botany, three of horticulture, including practical nursery work, a term in soils and crops, and one in farm mechanics, which includes practical road making, land drainage, and land measurement. The student also receives a fair training in English, algebra, drawing, book-keeping, and elementary physics and zoölogy.

If we now add to this the year's work in advanced forestry above outlined, we shall have an excellent preparation for the work of a ranger or forest overseer. There are many young men in the country, and especially in the section from which Berea students are drawn, who are well trained in logging and lumbering operations, familiar from boyhood with the qualities of timber, and who with such a course of study would make admirable recruits to the ranks of this most useful class of forest workers. Several have already entered upon this line of work, and I am convinced that as soon as the demand for such service, at a fair salary, becomes assured, there will be numbers ready to enroll in the work.

While we have two great universities and a number of other schools in the country ready to give a greater or less amount of technical training in forestry, I am not aware of any institution besides Berea that also undertakes to provide for the training of the ranger.

This sketch should not close without a word about the lectures in the preparatory school. The pupils here, though in grammar-school studies, are often grown men and women, and many of them do not follow the course beyond these grades, when they will make for themselves homes in the mountain coun-

ties, where the forest products have in the past far outweighed in value the agricultural. Here the word "forestry" has seldom been heard, except through Berea's teachings, and the waste by fire and axe is as deplorable as anywhere in our land. These young people will carry into hundreds of neighborhoods the ideas gathered from each winter's course of lectures. Their note books, some of them very ingeniously illustrated, are read over and discussed by the family and neighbors around many a mountain fireside.

The "Primer of Forestry" and other bulletins on forestry are read, and a foundation of public sentiment established which the coming years will show to be far reaching in its effects. Berea can modestly boast of teaching the elements of forestry to more people than any other institution in the country.

FORESTRY AND IRRIGATION IN CONGRESS.

MONTH OF MARCH, 1902.

March 3.

Mr Spooner, in the Senate, presented a memorial of the Board of Trade of La Crosse, Wis., remonstrating against the proposed opening to settlement of the Leach Lake Chippewa Reservation, in the State of Minnesota; which was referred to the Committee on Indian Affairs.

A message to the House from the Senate announced that an act (S. 3057) appropriating the receipts from the sale and disposal of public lands in certain states and territories to the construction of irrigation works for the reclamation of arid lands had passed.

Mr. Powers, of Maine, introduced a bill (H. R. 11997) granting to the Hawaii Dutch Company, Limited, the right of way over public lands in the districts of North and South Kohala, in the Island of Hawaii, for the purpose of constructing and maintaining ditches or canals and the necessary reservoirs, dams, and the like for irrigation and domestic purposes in said districts. Mr. Smith, of Arizona, introduced a bill (H. R. 11998) granting the Central Arizona Railway Company a right of way for railroad purposes through the San Francisco Mountains Forest Reserve. To the Committee on the Public Lands.

March 4.

The act (S. 3057) appropriating the receipts from the sale and disposal of public lands in certain states and territories to the construction of irrigation works for the reclamation of arid lands. Referred to the House Committee on Irrigation of Arid Lands. Mr. Stevens, of Minnesota, introduced a bill (H. R. 12092) to provide for a national park commission. Referred to the Committee on Military Affairs.

March 5.

Mr. Moody, of North Carolina, introduced a bill (H. R. 12138) for the purchase of a national forest reserve in the Southern Appalachian Mountains, to be known as the "McKinley Appalachian National Park and Forest Reserve." Referred to the Committee on Agriculture.

March 6.

Mr. Miller, from the Committee on the Public Lands, to which was referred the bill of the House (H. R. 11998) granting the Central Arizona Railway Company a right of way through the San Francisco Mountains Forest Reserve, reported the same without amendment, accompanied by a report (No. 772); which said bill and report were referred to the Committee of the Whole House on the state of the Union.

Mr. Needham, from the Committee on the Public Lands, to which was referred the bill of the House (H. R. 11538) providing the means of acquiring title to two groves of *Sequoia gigantea* in the State of California with a view to making national parks thereof, reported the same with amendments, accompanied by a report (No. 777); which said bill

and report were referred to the Committee of the Whole House on the state of the Union.

March 8.

Mr. Mondell, from the Committee on Irrigation of Arid Lands, to which was referred the bill of the House (H. R. 9676) appropriating the receipts from the sale and disposal of public lands in certain states and territories to the construction of irrigation works for the reclamation of arid lands, reported the same with amendment, accompanied by a report (No. 793); which said bill and report were referred to the Committee of the Whole House on the state of the Union.

March 10.

Mr. Ray, of New York, asked leave to file the views of the minority of the Committee on Irrigation of Arid Lands.

March 11.

Mr. Moody, of Oregon (by request), from the Committee on the Public Lands, to which was referred the bill of the House (H. R. 4393) reserving from the public lands in the State of Oregon, as a public park for the benefit of the people of the United States and for the protection and preservation of the game, fish, and timber and all other natural objects therein, a tract of land herein described, etc., reported the same with amendment, accompanied by a report (No. 872); which said bill and report were referred to the House Calendar.

Mr. Mondell introduced a resolution (H. Res. 161) that there be printed 3,500 copies of the list of books on irrigation (with reference to periodicals) compiled under direction of A. P. C. Griffin, Chief of Division of Bibliography, for use of Congress. To the Committee on Printing.

March 13.

Mr. Warren, in the Senate, presented a petition of the Interstate Irrigation Congress of Colorado and Nebraska, of Sterling, Colo., praying for the enactment of legislation providing for the reclamation and irrigation of the arid lands of the West; which was ordered to lie on the table.

March 17.

The bill (S. 270) to prevent trespassers or intruders from entering the Mount Rainier National Park, in the State of Washington, was considered as in Committee of the Whole. It directs the Secretary of War, upon the request of the Secretary of the Interior, to make the necessary detail of troops to prevent trespassers or intruders from entering the Mount Rainier National Park, in Washington, for the purpose of destroying the game or objects of curiosity therein, or for any other purpose prohibited by law or regulation for the government of the reservation, and to remove such persons from the park if found therein.

The bill was reported to the Senate without amendment, ordered to be engrossed for a third reading, read the third time, and passed.

March 19.

The President *pro tempore* laid before the Senate a communication from the Secretary of the Interior transmitting a draft of a bill providing for the extension of the limits of the Yellowstone National Park, and for the protection of the game therein, together with papers from the files of the Department, indicating the necessity for such legislation; which, with the accompanying papers, was referred to the Committee on Forest Reservations and the Protection of Game and ordered to be printed.

March 20.

Mr. Kittredge, from the Committee on Forest Reservations and the Protection of Game, to whom was referred the bill for the improvement of the Mount Rainier National Park, in the State of Washington, reported it without amendment and submitted a report thereon.

March 21.

Mr. Perkins presented to the Senate a petition of the Chamber of Commerce of Stockton, Cal., praying that an appropriation be made for the construction of a diverting canal to carry the flood waters of Mormon Channel into the

Calaveras River, in that state; which was referred to the Committee on Commerce.

March 26.

Mr. Gamble, from the Committee on the Public Lands, to whom was referred the bill (H. R. 3084) for the relief of *bona fide* settlers in forest reserves, reported it with an amendment, and submitted a report thereon.

March 31.

The bill (S. 255) for the improvement of the Mount Rainier National Park, in the State of Washington, was considered as in Committee of the Whole. It appropriates $25,000, to be expended under the supervision of the Secretary of the Interior, for the purpose of improving the Mount Rainier National Park, in the State of Washington, and for the protection of the park and the construction and repair of bridges, fences, and trails, and improvement and construction of roads. The bill was reported to the Senate without amendment, ordered to be engrossed for a third reading, read the third time, and passed.

THE PLANTING OF EXOTIC TREES IN SOUTHERN FLORIDA.

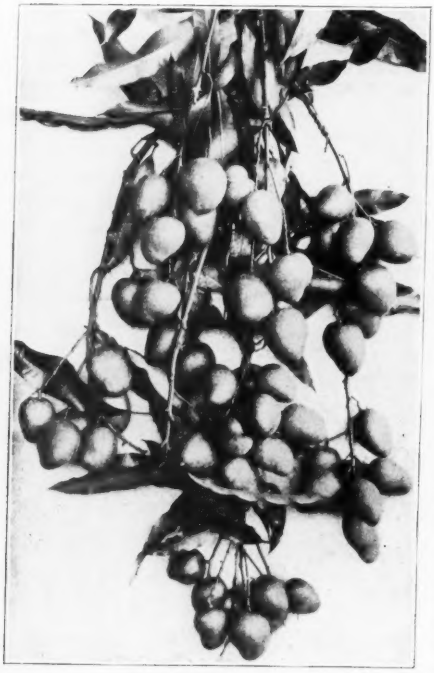
PART II.

By Dr. John Gifford,

New York State College of Forestry.

THROUGHOUT the tropical regions there are many leguminous trees which are valuable for the products which they yield and for soil betterment. Some of them yield tannin (Divi Divi); some valuable dyewoods (Logwood and Brazilwood). Many are very valuable for timbers; some are used as nurse and shelter trees, such as *Erthryna umbrosa*, which is used so much to shade choco-

POINCIANA REGIA IN NASSAU; SHOWS ITS UMBRELLA SHAPE WHICH GIVES IT ESPECIAL VALUE AS A SHADE TREE.



FRUIT OF THE MANGO (MANGIFERA INDICA).

late that it is called the "mother of the chocolate;" and many are used for shade and ornament because of the beauty of foliage and flowers. One of the commonest of the latter is *Poinciana regia*. It is a native of Madagascar, but was named for a governor-general of Cuba. The tree is one of the commonest shade trees of the tropics. Its flowers are flame-colored and its beans are long and brown. This tree is common in southern Florida, but as a shade tree deserves to be more frequently planted.

A tree which is being extensively planted in southern Florida is the Mango, the apple of the Tropics (*Mangifera indica*). It should not be forgotten, however, that this extremely beautiful and useful fruit tree yields a valuable wood. Its wood is soft and open grained, although as with many other tropical trees, the annual rings are not distinct. It is used in India for tea boxes, planks, doors, and window frames. It is sometimes stained to imitate Toon. Now Toon is the eastern twin of the West Indian Cigar Box Cedar. I presume that it is improper to suggest that the mango wood be stained to imitate the West Indian Cedar in those parts of the West Indies where Mango is plentiful and Cedar scarce. The Mango is too valuable as a fruit tree to be sacrificed. Although the Mango came originally from India, it is said that the mango fruit of the Western Hemisphere is of an inferior grade. There are some pretty good Mangoes just the same outside of the Orient, and I have heard it said that the best Mango of the Western Hemisphere is produced on the Island of Itamaraca, off the coast of Pernambuco.

Cedrela odorata. This extremely useful and beautiful tree is not a native of Florida. It was once abundant in Cuba, but has been practically exhausted for cigar boxes, boats, etc. When cigars are merely wrapped in paper or kept in an improper kind of box, not only is their flavor affected, but they are in danger of ruin from insect pests. At any rate, the fine aroma of this wood, its lightness, beauty, and other qualities fit it especially for this and hundreds of other purposes. It may be used in the place of Mahogany. It is excellent for any of the higher grades of cabinet work. One might easily mistake this tree for the European Walnut (*Juglans regia*). It has the same kind of foliage; the same general shape, color, and form of bark. It is a very rapid grower and a great seed-producer. The winged seeds are formed in pods which often hang in large bunches from the tree. I have been told that it can be easily reproduced from cuttings, but I have never tried it, and am therefore not certain. What appears to be annual rings in the wood are probably not annual at all.

There seems to be no periodicity of leaf-fall. With this as with other tropical species, the "personal element" plays an important rôle. I have seen two Cedrela trees within 100 feet of one another—one with a rich green active foliage and the other as bare as winter. This difference in leaf-fall I believe to be due to the spot in which the tree may

be growing. The rich foliage and porous wood require a great deal of moisture. If the tree is located in a moist place, I believe it will retain its foliage throughout the year and produce a very large quantity of very porous wood. The leaves would probably fall at fruiting time, but often in a very irregular manner. If the tree is located in a spot subject to drouthy spells, as are common in the tropics, I have no doubt but that it would drop its leaves three or four times a year.

There is a direct relationship between drouth, leaf-fall, rings, and porousness of wood in tropical countries. Although the tropics may receive immense quantities of rain in the course of a year, it falls in large amounts at a time, so that under the great amount of sunshine, evaporation, and transpiration there are many drouthy periods throughout the year, varying oftentimes a very great deal within a very small area. Now, the *Cedrela odorata* to do its best should have rich, moist soil, and under such circumstances I believe it will produce a larger quantity of excellent wood per year than any other species.

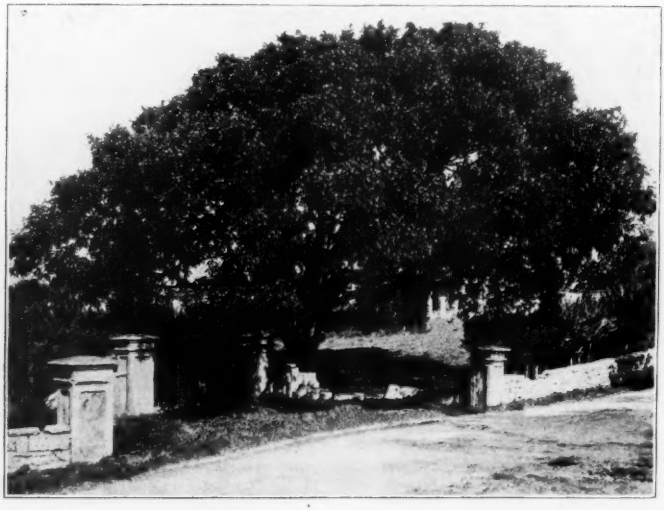
It is, however, very similar to the *Cedrela toona* of the Orient. I have both species growing together under glass, and the difference is slight. The Red Cedar of Australia (*Cedrela australis*) is the same as the Toon of India. Baron von Mueller, who named it, said afterward that it was not sufficiently different from the Toon to be given a distinct name. The Australian Cedrela is the one which is being most extensively planted for timber purposes in northern Australia. Its wood is red, darkening with age; it is light, figured, soft, easily worked, and very durable. It is used for furniture, joinery, cabinets, boat-building, carriage-building, ceilings, door-frames, and many minor purposes.

These trees, whether from Cuba, the Philippines, India, or Austria, should be given first rank, from both a lumber and a silvicultural standpoint. The man who plants *Cedrela odorata* on the proper kind of soil will reap, if no un- or insect ravage, a handsome profit in less than a quarter of a century.

CEDRELA ODORATA IN THE HAVANA BOTANICAL GARDEN.

There is one species of Cedrela (*C. sinensis*), the Chinese species, which will grow as far north as Washington, D. C. The wood is inferior to the species mentioned above, but with a little staining could be used as a counterfeit or substitute. The accompanying illustration shows a West Indian cedar tree in the Botanical Gardens at Havana.

Closely related to the Cedrelas is the Mahogany. In the open it is wide-spreading like the oak (see illustration), but in the forest it is tall and stately. This tree is still common in our tropics, but is scattered in dense tangles and is difficult to exploit. Were it not for this fact it would have been exhausted long ago. It is a great seed-producer and a vigorous grower. There are three great mahoganies throughout the world which are closely related; one is the Indian *Soymida febrifuga*, the other is the African *Khaya senegalensis*, and the



THE MAHOGANY AS A SHADE TREE.

other is our *Swietenia mahogani*, which is probably the best, although there is great diversity in quality and value.

This tree is native to the Keys of Florida. It may be seen in perfection on the south coast of the Isle of Pines. Lumbermen will soon begin to work on it, but the territory is of such a rough character that I doubt if they can exterminate it, or make the fortune out of it which everybody associates with this royal tree. Now and then a tree may still be seen on the Keys of Florida, growing with mastic and crabwood, in the strips left by the pine-apple growers to protect their plantations from the storms which sometimes occur in that district.

PUMPING WATER FOR IRRIGATION.

FOURTH PAPER.

MOST of the water pumped for purposes of irrigation is raised by windmills operating vertical plunger pumps. There are many localities, however, especially in sheltered valleys. where the wind cannot be depended upon during the summer season, and it is neccessary to provide some form of power which can be operated at any time. Various kinds of engines are used for this purpose, the variety being dependent largely upon the character of fuel available and its cost. Where wood or coal can be procured at reasonable rates, steam-engines are utilized, and in other localities, where these fuels are expensive, gasoline or other products from crude petroleum or this oil itself is used.

Throughout the principal farming regions there are usually to be found threshing or traction engines, and most farmers are familiar with their use. During a time of drouth, when a question of pumping water for irrigation comes up, the first thought of the farmer as regards obtaining power for pumping is that of utilizing one of these engines. Many ingenious devices have

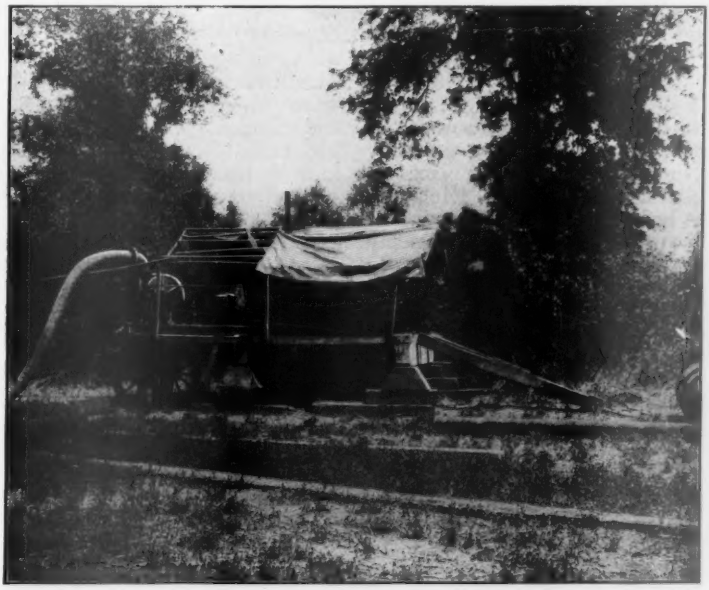
resulted from the necessity of using such machinery which happens to be at hand or easily procurable.

For use with a threshing engine the most efficient pump is centrifugal. One of these can be purchased at short notice from dealers in machinery. Before ordering a pump, the depth to water in the well or creek must be known, as well as the total lift and the power of the engine. When these and some other details are settled upon, a pump can be ordered of such size as to be best adapted for the situation.

The accompanying figure shows an engine arranged with a centrifugal pump upon a platform, the whole being mounted upon heavy wagon wheels, so that the pumping plant can be hauled from point to point. Flexible suction and delivery pipes are connected, so that water can be drawn from a creek or well and carried by the shortest way to the fields.

The pumping plant illustrated is one of many utilized by the farmers in California. In this particular instance the owner found that he could not rely upon an irrigation ditch and resorted to these means of obtaining a needed supply. The success attained with these devices has been such that the owners hesitate to abandon them, even for improved systems of ditches.

The machine shown in the view is an 18-horse power Hercules gasoline engine. It uses 22 gallons of distillate, costing 10½ cents a gallon, for a working day of ten hours, or in all $2.33 per day. The centrifugal pump to which the engine is belted cost $150, and has a capacity of 700 gallons a minute, or nearly 1.4 cubic feet per second. The water is pumped directly from the creek, and is forced through an eight-inch pipe to the fields to be irrigated, being often elevated 55 feet. The average cost of operation has been found to be $1 an acre of land irrigated.



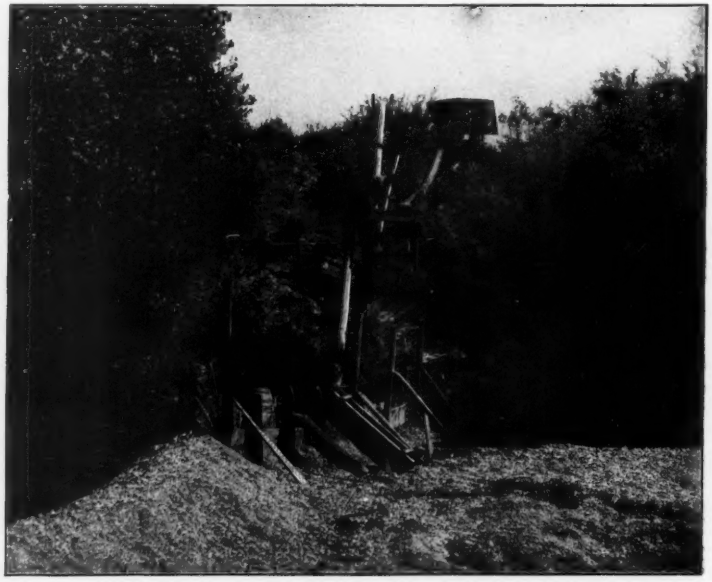
PORTABLE PUMPING PLANT IN CAPAY VALLEY, CALIFORNIA.

Another portable pumping plant is shown in the view taken on Cache Creek, California. In the background is an engine, extending from which is a belt connected to a centrifugal pump

raising water from the creek. A temporary dam causes a small amount of water to accumulate, and this is pumped by the centrifugal pump up the bank and to the fields. In this creek the flow ceases frequently during July, but pools are to be found where the water percolating through the gravels comes to the surface. From these depressions the pumps obtain a supply, the pools filling gradually after the pumps are stopped.

For fuel, straw, brush, wood, and coal are frequently used. The average price paid in the Sacramento Valley, California, for straw is 75 cents a load; for wood, $4.00 a cord; for coal, $8.50 per ton, and for gasoline 11 cents a gallon. The pumping engines, being portable, are taken about from place to place and used in turn by neighbors. Each contributes his share of the expense, the average cost of irrigation being in many cases less than that paid for the supply from gravity ditches. This can hold true only where water can be had at moderate depths, say 20 or 30 feet beneath the surface. For much greater depths the cost increases to an amount to be prohibitory.

These devices, which are more or less temporary or home-made, can be improved upon if the entire outfit is purchased from manufacturers experienced in such matters. For temporary emergencies it is sometimes necessary to employ any machinery at hand, but if a farmer is proposing to irrigate and has not already any machinery at hand, he should ascertain the character of his water supply, the height to be lifted, and furnish these facts to an experienced manufacturer of irrigation pumps in order that the highest efficiency may be had, or, in other words, the machinery planned on such lines that the necessary quantity of water may be raised with the least amount of fuel.



PUMPING PLANT ON CACHE CREEK, CALIFORNIA.

RECENT PUBLICATIONS.

"Forstästhetik." By HEINRICH VON SALISCH. Second edition. Octavo, paper cover, pp. 314. Illustrated with sixteen full-page heliotypes and fifty-nine half-tones and figures. Berlin: Julius Springer, 1902.

A second edition of "Forstästhetik," by Heinrich von Salisch, should interest all professional foresters, as well as lovers of nature generally. The excellent reputation enjoyed by the author for more than fifteen years as an interpreter of the beauties of trees and forests is confirmed by this second appearance of his book, which has been enlarged by valuable additions to the text and enriched by numerous illustrations.

"Forstästhetik" has the peculiar distinction of being the only book ever written upon the subject with which it deals. It is a critical study of the æsthetic value of artificial forests. Such forests, as a result of the careful, systematic treatment which they have received, have developed special characteristics and present a great variety of beauty and expression. These forms of beauty are worthy of study and interpretation, and may be brought out to advantage in the hands of a forester of taste. By adding a knowledge of forest æsthetics to a thorough understanding of the usual principles of forestry, the beauty of a forest may be greatly increased without sacrificing any of the material benefits which may be rightfully expected from a careful system of forest management.

The book is composed of two parts, each of which is divided into two sections. Section A of Part I treats of the scope, value, and history of forest æsthetics and of the philosophy of beauty. In Section B the author first discusses the relation between natural and artistic beauty and the significance of color in landscape, and then explains the sources of beauty in some of the principal components of the forest, including the most important German forest trees. Section A of Part II is devoted to a study of the æsthetic effects resulting from the various operations involved in the highly developed systems of German forest management, and is based upon the truths and principles set forth in Part I. In this section the author considers such questions as the construction of road systems, the subdivision of forest areas, the rotation of the forest, and the different modes of regeneration. The last section deals with a number of special measures for the adornment of the forest, which, in the author's opinion, may rightfully be included within the scope of forestry.

There is a natural inclination among foresters, American as well as European, to oppose the introduction of æsthetics into forestry. As the aims of forestry, in the minds of most people, are essentially practical and utilitarian, there is a fear that æsthetic considerations or "sentimentality" may interfere with their free execution. Mr. von Salisch meets such criticism by showing that forest æsthetics is distinct from landscape art, and that an intelligently developed system of forestry will in itself produce a great deal of beauty. It is only in the last section of his book that he suggests any departure from this fundamental idea. While in that section he goes so far as to propose certain measures belonging more properly to landscape art, a careful consideration of the subject will show that the measures selected are in reality to a certain extent justified under the exceptionally advanced system of forestry prevailing in Germany. Mr. von Salisch, however, does not at all approve of the idea of transforming forests into parks; on the contrary, he is even inclined to discourage the establishment of large parks on the ground that such a policy creates unremunerative areas (p. 209).

Foresters who have not read Mr. von Salisch's book will possibly be surprised to learn that the æsthetic side of forestry is itself decidedly helpful in a number of ways in furthering the material interests of the forest (pp. 4 to 10).

The author's treatment is marked by breadth of knowledge, thoroughness, careful discrimination, and refinement of taste. The style, though occasionally somewhat involved—at least for American and English readers—is generally clear and specific and often decidedly pleasing. Though dealing with an entirely new subject, the author is free from all self-assertiveness. One of the chief merits of the book is its suggestiveness. The text is interspersed with numerous extracts from writers on forestry who have incidentally referred to forest æsthetics. In treating the subject from these various points of view the author displays exceptional constructive ability, as well as a high degree of critical insight.

The heliotype illustrations, which are very well executed, form an attractive feature of the book and, together with the half-tones and figures, are helpful in connection with the text.

The ideas suggested in this book naturally grew out of the peculiarly exact methods of forestry practiced in Germany, and many of them are hardly applicable to the United States, where, for some time to come, forest operations will have to be adjusted to comparatively crude conditions. It does not follow, however, that the book before us has not considerable practical value for American foresters. Enormous areas, including some of the finest scenery of the country, are being entrusted to them. As years go by, people are becoming more and more interested in these forest areas as places offering recreation and a needed change from the busy life of cities; places where natural beauty and quiet may be enjoyed for their own sakes. This attitude of a large class of people should not be disregarded by the forester. When he learns to

appreciate to the full extent the possible development of the æsthetic side of his profession, he will be qualified to meet the arguments of such people in a broad spirit of mutual understanding, and will, moreover, derive a large additional share of enjoyment from the woods in which his pathway so largely lies Forest æsthetics should not be regarded as distinct from forestry, but, in truth, as an evidence of its highest and most perfect development. The recognition of this fact cannot but reflect favorably upon the profession of forestry, and will give it an added dignity and a larger sphere of influence.

G. FREDERICK SCHWARZ.

Our National Parks. By JOHN MUIR. Pp. 370. Illustrated with eleven half-tones and a map. Boston: Houghton, Mifflin & Co. 1902. Price, $1.75 net.

John Muir, geologist, explorer, and naturalist, and perhaps the best informed of any living man on the natural resources of the western United States, has written an unusually readable book under the title of "Our National Parks." The purpose of the volume the author states in the preface in these words: "In this book . . . I have done the best I could to show forth the beauty, grandeur, and all-embracing usefulness of our wild mountain forest reservations and parks, with a view to inciting the people to come and enjoy them and get them into their hearts, that so at length their preservation and right use may be made sure."

The book is divided into ten chapters, the opening one being a description of the various national parks and forest reserves of the West. The "Yellowstone National Park" comes next, and in this the author has a subject that gives full scope for his rich descriptive style. Following this, the next six chapters contain the most comprehensive and interesting description to be found of the celebrated Yosemite National Park. This portion of the book contains a chapter on the "Yosemite National Park;" then "The Forests of the Yosemite Park" are described. Next are "The Wild Gardens of the Yosemite Park;" then some time is spent "Among the Animals of the Yosemite Park," likewise the "Birds," and this portion closes with a chapter on the "Fountains and Streams of the Yosemite National Park."

Next in turn comes a chapter on the "Sequoia and General Grant National Parks," in which there is contained a splendid study of the Big Trees (*Sequoia gigantea*), and the book ends with an interesting chapter on "American Forests."

To readers more especially interested in forestry, the chapters on "The Forests of the Yosemite," "The Sequoia," and "American Forests" will prove most timely. The description of the Big Trees is especially well done, and Mr. Muir's many visits to the Sierras have given him opportunities possessed by few to study these trees. Some idea of his long acquaintance with the Big Tree region may be had from a single sentence in his book: "One of my best excursions among the Sequoias was made during the autumn of 1875."

Two points especially noteworthy in this book are the author's enthusiasm and his exceptionally beautiful style. Upon first reading one is inclined to think that Mr. Muir sees too many beauties in that western country, and yet on second thought we must admit that thirty or more years are a good test, and he has had the best opportunities to learn the truth. His observations are all at first hand, as the book so plainly shows. He is true to his text, "Going to the woods is going home."

The book abounds in beautiful passages. We cannot refrain from quoting here the following concerning the lumbering of the Douglas spruce:

"Felled and peeled and dragged to tidewater, they are raised again as yards and masts for ships, given iron roots and canvas foliage, decorated with flags, and sent to the sea, where in glad motion they go cheerily over the ocean prairie in every latitude and longitude, singing and bowing responsive to the same winds that waved them when they were in the woods. After standing in one place for centuries they thus go around the world like tourists, meeting many a friend from the old home forest; some traveling like themselves, some standing head downward in muddy harbors, holding up the platforms of wharves, and others doing all kinds of hard timber work, showy or hidden."

If you want to learn about the glaciers, mountain peaks, canyons, and great waterfalls of the West; of the habits of the animals, from the squirrel to the moose; plant life from the Big Trees to the wild flowers—in fact, be brought face to face with Nature's works, this is the book. Taken altogether, it is the best written and most valuable nature book we know of.

The *Atlantic Monthly* for April contains an unusually interesting article by Paul Griswold Huston entitled "The Day's Work of a Forester." This article contains a careful description of the field and office work required of foresters, and also the importance of an intelligent exploitation of forests. Mr. Huston was for some time an employé of the Bureau of Forestry, and had a good opportunity to study this subject. The article gives a good insight into the life of the forester, and is a welcome addition to the literature on the subject.

Typical Forest Trees. Three series of 8 photogravures, 9 x 12 inches, of well-known forest trees. A. W. Mumford, publisher, Chicago, Ill. Price, 40 cents a series.

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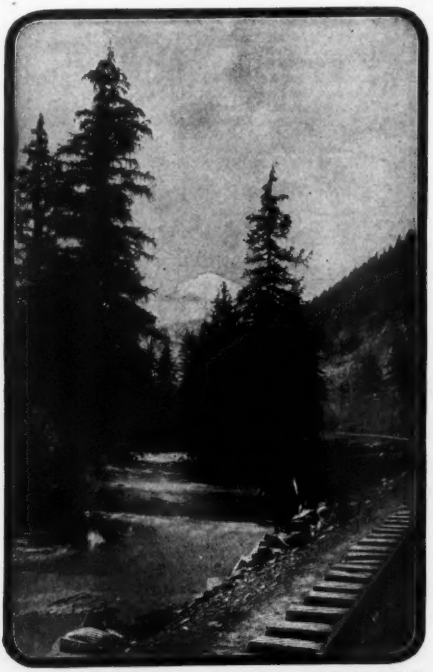

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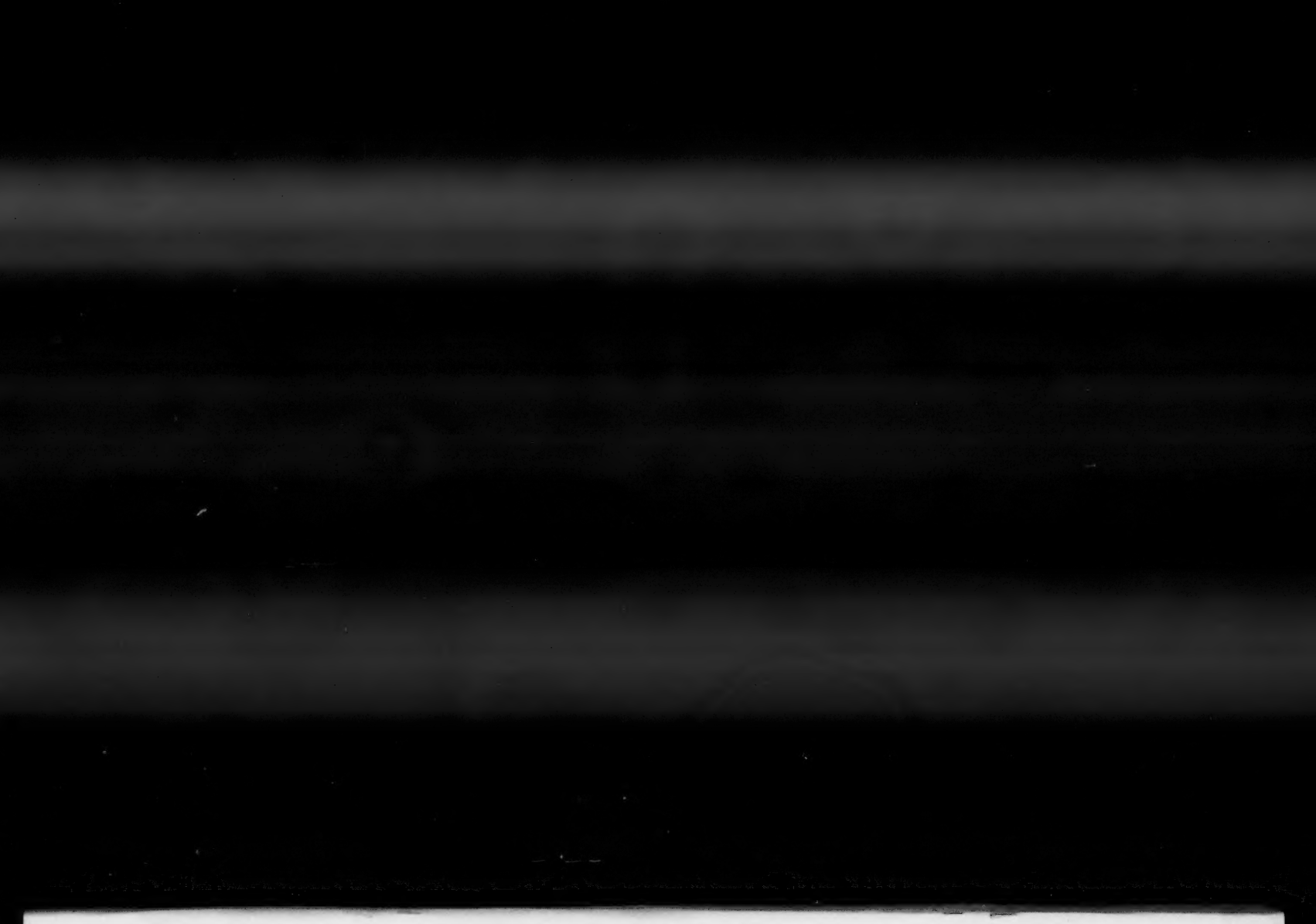
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